POSTHARVEST TECHNOLOGY

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POSTHARVEST TECHNOLOGY

MONDAY, JULY 25, 1983

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT,
Decatur, Ill.

The subcommittee met, pursuant to notice, at 9:06 a.m., in the Parquet room, Millikin University, Decatur, Ill., Hon. Richard Durbin presiding.

Also present: Representatives Evans, Simon, and Skeen.

Mr. DURBIN. I'd like to welcome everyone to this hearing of the Investigations and Oversight Subcommittee of the House Science and Technology Committee.

I'd like to welcome everyone today and especially express my appreciation to Roger Miller, the president of Millikin University, for hosting this important hearing.

Everyone in this room is aware of the unemployment that the Nation and this region, particularly, has suffered. Most of the counties in our area have had to bear the consequences of having some 13 to 23 percent of their breadwinners being out of work. This is not only a sad situation, but an unacceptable one, and one we all must work together to find a way to solve.

On the Science and Technology Committee, we've examined questions of unemployment, economic growth, productivity, and the role of technology in revitalization of our industries.

Many of our efforts have focused on high technology and many communities are now actively seeking to build high-technology corridors. But it seems to me, that a key element in this high-technology search is to find the right technology to utilize local resources and make our local industries grow.

While there are almost as many solutions to economic problems as there are economists, it also seems to me that some sectors of our economy are more fertile ground than others for policies that will get the economy moving again.

That's why we've come to Decatur today, to look at local opportunities and how we can assist in Congress and work with private business, universities, and State and local governments to get the economy moving again.

The subject of this proceeding today is "Postharvest Technology," the fertile ground I hope we're looking for. The postharvest sector, as most of you well know, is a major portion of the Nation's economy and has the lion's share of the agricultural economy. Agriculture counts for some 20 percent of our gross national product in this country and the postharvest phase comprises some 83 percent

of that figure. The Nation's food bill was, roughly, $300 billion last year, 10 percent of our entire gross national product, and nonfarm activities were about 72 percent of that sum.

Postharvest economic activities also comprise 86 percent of the jobs involved, and half of the energy consumed in agriculture, so it's clear that any way you slice it, this sector of the economy is important. Any farm family can tell you that the largest part of your food bill goes to processing and not the farmer. We cannot lessen our efforts to make certain that our agricultural producers receive a fair return for their crops. But neither can we ignore the vast potential in consumer demand which goes untapped for lack of a more coordinated effort in postharvest technology.

Such figures paint a rosy picture, the ones relative to the portion of the gross national product involved in agriculture. However, as we will hear from some of our distinguished witnesses today, there is a lot of room for growth in food processing, transportation, and marketing. Our overall productivity in this sector has not kept pace with the rate of agricultural production nor with the manufacturing sector. We have a large margin in which to improve productivity, create new industries and thereby provide more jobs. One of our local challenges is how we can develop growth in the postharvest sector.

What we will also hear today is that one of the real keys to growth will be technology. Computers are improving on marketing, recordkeeping and planning. New chemical processes will give us new applications for our crops, and increase our markets, and mechanical engineering can bring us better productivity and more growth and, once more, more jobs.

And the key to technology and innovation is research, which needs the support of the Federal Government, as well as the private sector.

Without the Government's support of electronics, we would not be seeing today the revolution in computers that we read about in every morning's newspaper.

If the USDA had not been providing healthy support to our system of land-grant colleges, many of the major advances we have seen, both on the farm and off, could not have taken place.

So when we see that the critical postharvest sector is only getting 18 percent of the Federal research support in agriculture, less than it was in 1966, we need to examine how we can use these resources more effectively and how we can increase our commitment to this important area of research.

We will also examine the other ways in which government can help, other than by simply writing more checks. We must examine how our system of price supports and export assistance can better assist our technological efforts, and we need to insure that a steady stream of experts are trained each year.

It is hard for us to have a technological revolution without the technical revolutionaries. More importantly, we need to understand how the vast resources of universities like Millikin University, University of Illinois, and, basically, the other resources in educational institutions in this area, like Richland Community College, can assist us in growing.

New relationships can be forged between universities, industries, and government, to cooperate and produce to market the new products that we need domestically and abroad.

I look forward to today's hearing and I'd like to thank our participants in advance for the time and effort they have taken to appear here today.

I'd like at this point to recognize my colleague on this subcommittee, a gentleman who hails from the State of New Mexico, and was kind enough to invite me to attend a similar hearing, relative to some local problems in Las Cruces, N. Mex., a gentleman highly regarded in the U.S. House of Representatives and the ranking Republican on the Investigations and Oversight Committee, and if you'd like to say a few words, Congressman Joe Skeen from New Mexico.

Mr. SKEEN. Thank you very much, Dick, and I just want to underscore a few words and we'll get on with these hearings.

I want to thank you very much for your hospitality and it's been a delight for me to meet so many of the Illini, because both of these gentlemen, Paul Simon and Dick Durbin, have visited New Mexico and I wanted to see what conditions prevail that would drive them out to such dry, barren country. And I find that the folks here are very hospitable, we were fed well last night and were taken care of and your staff was responsible.

Thank you for your participation and, Paul, it's a delight to see you here. I do think this is a very serious question and one that bothers me. I am a primary producer. I am in the sheep and cattle business. I raise sheep to make money and cattle just for the prestige. The market hasn't been all that good.

One of the disconcerting things about being in agriculture today is the fact that though our costs—the costs of our products at the production level—have been extremely low for all these years, the consumer is not getting the benefit, because the primary producer is getting a low cost for his product because the technology in the postharvest area has somewhat lagged that of productivity. I think the news release accentuated that, so I am very interested in what we'll hear today from the Department of Agriculture and other representatives from the private sector.

Thank you so much for the participation and I've enjoyed your country very much. It's a very beautiful place.

Mr. DURBIN. If we don't get some rain soon, we're going to need your irrigation techniques.

Mr. SKEEN. We can talk about praying and things that we do.

Mr. DURBIN. I might add, and I think Joe mentioned it, that he and I serve on the same committees, both Agriculture and Science and Technology, and at this particular hearing, although it's sponsored by the Science and Technology Committee, it attempts to embrace, I think, some of the major elements that both committees are facing.

Two other individuals will be joining us today, one of whom serves on Science and Technology Committee with me, and is no stranger to Decatur, Ill. He is the former State representative from the Madison County area, former State senator from that same area, served as our Lieutenant Governor in the State of Illinois for

4 years, and has been a Member of Congress from the southern portion of the State now for 8 years, is it, Paul, 7 or 8 years?

Mr. SIMON. Eight years.

Mr. DURBIN. He is no stranger to Decatur, central Illinois, or the problems that are faced in downstate Illinois, as we attempt to reconcile some of the major challenges ahead.

It is my pleasure at this point to introduce my colleague from the House Science and Technology Committee, Paul Simon.

Mr. SIMON. Thank you very much, Dick. It's a pleasure to be here. I am not on this subcommittee but I am an interloper, in a sense, although I serve on the full committee. I am here to learn and I am pleased to be here with Dick Durbin and Joe Skeen. Dick has made an excellent impression on his colleagues as a new Member of Congress and Joe has been a very active leader in the House, also, and it's a pleasure to be with both of them.

Let me just add a couple of points very briefly: One, I am pleased, Mr. President, to be on the campus of Millikin University again. It's been a few years since I've been here and the campus has changed and you're moving ahead and as chairman of the subcommittee that has as its jurisdiction the whole higher education field, I am pleased to see this school move ahead as it is.

The second point I would make simply underscores what Dick Durbin has said in his opening remarks about cooperation between the Government side and the private side. I think sometimes we get into comfortable antagonisms. It is true in labor/management, and it is sometimes true in the area of Government/private relationships. This is an area where we ought to be working together and I hope one of the results of this hearing will be that we will find some areas where we can cooperate more.

We're being joined by Congressman Lane Evans from the Rock Island-Moline area. We're happy to have you here.

Mr. DURBIN. Thanks, Paul.

Lane, I'm glad you're here and we've just given your speech. That will liberate you from any worry about following the script.

Lane Evans, like myself, is a new Congressman and is from the Rock Island area, who shares many of the same concerns we do about unemployment and how to utilize the resources that we have in our downstate Illinois communities for our own future.

Lane and I serve on the House Agriculture Committee together and sit next to one another and I've constantly asked him how to vote. So, if you have any quarrel with my voting record, it's all his fault.

At this point, I would like to introduce Congressman Lane Evans from Rock Island, Ill.

Mr. EVANS. Well, I will waive my opening statement since I am late, Dick, but I appreciate the opportunity to come down. I am on the Agriculture Committee and not on the Science and Technology Committee but, obviously, this is an issue of great concern to not only the people that will be employed in the new technologies that we can develop, but also our farmers who can transport their goods or their products cheaper and process their goods here and export them to other markets. So I am pleased to be here this morning.

Mr. DURBIN. Thank you.

At this point, I would like to recognize the president of Millikin University for a few words of welcome. President Roger Miller.

STATEMENT OF DR. ROGER MILLER, PRESIDENT, MILLIKIN UNIVERSITY, DECATUR, ILL.

Dr. MILLER. I do want to welcome you most sincerely, ladies and gentlemen, and it seems to me entirely appropriate, Congressman, that hearings of this type be held on a university campus, where our very existence is that of trying to come up with new knowledge and sharing knowledge. And this type of hearing seems to be appropriately located on a university campus.

I'd be remiss as a university president if I did not take about 2 minutes—or maybe even less than that—to tell you a little bit about Millikin University. I have some strangers here and I'm not going to pass up this opportunity, particularly since it might be put on tape and last for awhile. We are, indeed, a small private university of about 1,500 students. I want to point out that in the hard economic times of the last 3 years, our placement record for our graduating class has been 94 percent.

Now many of you who are Illini or anyone else who want to compete with that record, let me know, and we will be glad to put the statistics out.

Incidentally, Mr. Skeen, all people who live in Illinois are not Illini.

Mr. SKEEN. I got that distinction.

Dr. MILLER. I wanted to clear that up. There are some Big Blue around here, too.

Mr. SKEEN. Being political, I was trying to cover all bases.

Dr. MILLER. Well, don't forget the Big Blue in Decatur because we have more Millikin alums in Decatur than we do Illini.

Mr. SKEEN. I receive the message.

Dr. MILLER. One of the great names in the agriculture business in Illinois was Taber and we're honored to have the Taber School of Business and Engineering at Millikin University. I want to point out that it's one of the largest private undergraduate schools in the Midwest and we're very proud of our school of business.

The university also has a college of arts and sciences, a college of fine arts, and a school of nursing. I am pleased to report that we have been in the black for 12 consecutive years. We've been growing and building buildings at the same time. These buildings were put up on our own, they are paid for, and we're terribly interested in these agricultural-type hearings, because we own about 6,000 acres of farmland, gentlemen. So we're very interested in the price of beans and the price of corn, that type of thing.

We do serve primarily Illinois students. About 90 percent of our kids here at the university are Illinois students and a large percentage of these are downstate, small-town, rural, agricultural-type students. We're small but we account for over $30 million a year into Decatur County, and we're very much an active part of this community and this county.

One last comment: One of the census statistics that are kept every year are the corporate support dollars going to private and public colleges and universities throughout this State. There are

six colleges and universities traditionally at the top of that list. They are the University of Illinois, University of Chicago, Northwestern, DePaul, Loyola, and IIT, Illinois Institute of Technology. They always are in the top six. Consistently, in terms of total corporate dollars given to colleges and universities, all public and private, Millikin ranks seventh out of the whole State. Although small, we receive a lot of corporate support.

The reason is very simple. We work hard to earn that support and we try to fit in the Decatur community, the Illinois community, and we feel that we are doing something for business and industry in this State and they are going to do something in return.

It's a very brief, short synopsis of the university. I hope I didn't exceed my 2 minutes, Dick. If I did, my apologies, but I couldn't pass up the opportunity to say a few words.

Make yourselves at home. We hope you enjoy the day. We hope the facilities turn out to be to your liking.

Mr. DURBIN. I'd like to say at the hearing that you've had Millikin University in the black for so long, I think we'd probably like to have you out to Washington as a consultant. I think you could give us some advice on deficits.

Our first panel has been called together to give us an overview of some of the major issues facing us today. I would like to call to the stage at this point Dr. Michael Phillips with the Office of Technology Assessment in Washington, D.C., and Dr. Mary Carter, Deputy Administrator, Agricultural Research Service, U.S. Department of Agriculture. Sorry, I gave the wrong title, Associate Administrator of the Agriculture Research Center.

We welcome you both today, the 20th Congressional District, Central Illinois, Macon County, Decatur and Millikin University.

I might tell you that Dr. Phillips is well known to those of us who have prepared for this hearing today, having authored, or at least gathered together as editor and publisher, the information which we found to be invaluable in preparing for the hearing, a publication of the Office of Technology Assessment, known as Agricultural Postharvest Technology and Marketing Economics Research.

Dr. Phillips, why don't you start off and we welcome you here this morning to Decatur.

STATEMENTS OF DR. MICHAEL J. PHILLIPS, OFFICE OF TECHNOLOGY ASSESSMENT; AND DR. MARY E. CARTER, ASSOCIATE ADMINISTRATOR, AGRICULTURAL RESEARCH SERVICE, U.S. DEPARTMENT OF AGRICULTURE, WASHINGTON, D.C.

Dr. PHILLIPS. Thank you, Congressman Durbin, and it is certainly my pleasure to be here today to represent the Office of Technology Assessment which is, as most of the members know, a research support agency to the Congress, and to talk about a very important subject that we feel, in the work that we've done for Congress in the last 2 or 3 years in the area of food and agricultural research, that this is one of the areas that we felt important enough that needed to have some special focus put on it to bring together for the public some of the problems that have ensued.

We have issued a report which you kindly made reference to and my purpose today is merely to just briefly summarize what the major findings are of that report, to help provide an overview today for your hearings.

We have faced for many years a very interesting paradox in the food and agricultural sector. The industrialization of American agriculture during the past decade has diminished farm numbers and farm populations. And while the total agriculture production has increased, you look at the input, the finance, the service, the processing, transportation, and distribution industry surrounding production agriculture, they have become the dominant economic components of the food and agricultural system.

The transformation of production agriculture from a major economic sector of the economy to minor status has been in progress since the founding days of the republic.

However, it's progressed rapidly in the post-World War II era, via the technological revolution involved in the mechanical, chemical, biological and managerial innovations on the farm. And what has emerged from this process is a highly interdependent subsector of the U.S. economy for providing food and fiber for consumers at home and abroad.

Emphasis by agricultural scientists has been placed upon the technical, economic, and social aspects of production agriculture as the food and fiber system has changed over time.

However, when you look at it in terms of value added, employment, contribution to gross national product, balance of trade, energy usage and impact on inflation, the food and fiber system, beyond the farm gate, did approximately twice that of production agriculture.

In activities beyond the farm gate—here we are referring to marketing or the postharvest sector and in terms of our report where we categorize postharvest technology and marketing economics—which brings in the social research as well as the physical, biological and chemical research—this includes all of the technological and economic transformations that occur to agriculture products between harvesting and consumption.

But when we do refer to postharvest technology research that encompasses storage, assembly, processing, packaging, warehousing, transportation, and the distribution of agricultural products throughout institutional food trade in things like restaurants, cafeterias, et cetera, and the wholesale and retail outlets.

In my testimony, I'm just going to cover four areas for you today. I want to talk a little bit about the importance of the postharvest sector to the national economy. Let's look at the public investment in this postharvest activity in terms of research. Let's look at who benefits from this research and then briefly look at what are the role of the public and private sectors in the conduct of this research.

During 1982, as you've already mentioned, Congressman Durbin, Americans spent almost $300 billion for food. Approximately 30 percent of that went to onfarm production costs. The rest went to postharvest activity. And to appreciate the impact of the postharvest sector on the national economy, consider the following facts:

Consumer food expenditures have risen $183 billion since 1971, and increases in postharvest cost have accounted for 75 percent of that amount.

The food and agricultural sector accounts for 22 percent of total U.S. employment; 86 percent or about 20.5 million people are employed in this postharvest sector.

The food and agricultural sector accounts for 20 percent of the gross national product, as you so rightly pointed out here this morning. Almost 18 percent of that comes from industries in the postharvest sector.

The food and agricultural sector consumes an estimated 17 percent of the total U.S. energy supply. Production agriculture consumes 3 percent; the postharvest sector, 8 percent; the remaining 6 percent is used in the home in preparing food for consumption.

The postharvest sector has also contributed to some of the economic problems facing the Nation, particularly inflation and lagging productivity. Over the past decade, there has been a significant increase in consumer prices and inflation in food prices has had a profound affect on the national economy.

During the 1970's, food price inflation averaged about 8 percent a year and it accounted for an average of 26 percent of inflation in the general economy.

Food price inflation peaked at 14.5 percent in the years 1973 and 1974, and it accounted for nearly 50 percent of the inflation in the general economy during those years. And as we indicated earlier, the postharvest sector accounted for 75 percent of these food price increases.

Labor and energy have been the major components of these increases. Productivity gains in the postharvest sectors have been less dramatic than those achieved in farming. Most postharvest industries are afflicted with lagging or declining growth, and those are depicted in figures 1 and 2 in the back of my prepared remarks.

The problem is especially evident in the food transportation, the food retailing, the food service and some food manufacturing industries. Labor productivity growth rates in the food and manufacturing sector vary considerably by industry. Although increases in labor productivity growth rates have occurred since 1972 in some industries, for example, wet corn milling and soft drink manufacturing, in other industries such as meat packing, sugar, candy, breakfast cereal, there have been no significant increases. And in one industry, particularly blended flour, productivity has actually declined.

In the food distribution sector, labor productivity growth rates in rail and truck transportation have not increased significantly since 1972. And in retail food stores and in eating and drinking places, productivity now is significantly below the 1958–72 levels.

Lagging productivity growth in food processing and distribution sectors, in addition to contributing to lagging productivity in the general economy, has, of course, contributed to those increased rates of food price inflation that we talked about just a little bit ago.

However, despite the importance of this postharvest sector to the national economy, relatively little attention is paid to it by the

public research sector. At least that's been true in the past 10 to 15 years.

Research expenditures, particularly by the Federal Government, for this sector have historically been low but, more importantly, they have not increased in real terms. In fact, a major debate annually between the executive branch and Congress is whether to provide any funding to this area of research.

Executive branch members, including the USDA and the Office of Management and Budget, have taken the position in the past that it's no longer necessary to invest in this research, the implication being that private firms have sufficient resources to conduct their own research.

Compared with production research, postharvest research has not been a major public sector priority. In 1981, for example, $260 million or 18 percent of the combined research expenditures of USDA in the State agricultural experiment station, went to postharvest research; 69 percent, or almost $1 billion, went to the production research area.

Further, public expenditures for postharvest research in constant dollars have only increased about 1½ percent, between 1966 and 1981, and since 1978, they have declined 8 percent.

Analysis of the USDA State experiment station individual expenditures, however, show two different and distinct patterns: USDA constant dollar expenditures for in-house postharvest research in funds and transmitted to the State agriculture experiment stations and other agencies decreased 17 percent, between 1956 and 1981.

Within USDA, the Agricultural Research Service declined by 20 percent. The Economic Research Service decreased by 10 percent during this period.

Now, in contrast, the State agriculture experiment stations around the country for postharvest research increased by 32 percent in constant dollars from 1966 to 1981. So by 1981, the State agriculture experiment stations have increased its share of total public expenditures—in other words, USDA and State agriculture experiment stations combined for postharvest research from 38 to over 50 percent of the total of all the research that's done in this area.

When you look at the State agriculture experiment station, you find that its State appropriations that account for the majority of the funds for this research. These appropriations increased from 43 to 56 percent of the State experiment stations' funds for postharvest research.

The Federal Government's share, to this date, for postharvest research during this time period declined from 53 to 38 percent. So what this is saying is that now the State appropriations comprise over one-half of the expenditures for postharvest research in the State agriculture experiment stations.

This is important when we look at who the beneficiaries are of the research.

Postharvest research provides a range of benefits. It can include increased productivity and reduced real price of the cost of food. It provides enhanced food quality, safety, nutrient content, new and improved food products, reduction in food losses due to waste; and

on the social research side, the information for good decisionmaking. Postharvest research benefits can accrue to a number of beneficiaries, and I have listed them in my testimony.

Briefly, they can include the farm producers because by improving storage, processing, retailing, and transportation systems, postharvest technologies enhance the value of farm commodities, by letting producers distribute the sale of these products over time. So farmers can obtain increased income by selling products off-season and in nonproducing areas.

In addition, marketing services increase information available to producers, increasing their chances to sell at more favorable market prices. Consumers in the general economy benefit from postharvest research technologies.

Technological changes in this area reduce the cost of product transformation or marketing services and these can reduce retail prices for consumers. Also, consumers can benefit from improved market or price information, which leads to more informed decisionmaking; and, in addition, consumers also benefit if food quality, nutrition, safety, and convenience are improved.

The distribution of postharvest benefits varies by income and during our studies we found that the ratio of consumer benefits to family income was almost four times higher for the lowest income class than for the highest. In other words, the payoff in postharvest research and technologies has substantially greater beneficial impact on low-income consumers than on high-income consumers.

Marketing firms also benefit from this type of research, depending on the competitive structure of the industry. In a competitive economic environment, firms that adopt more efficient and productive technology might pass these savings on to consumers. This could provide a higher price for farm products and lower retail cost to consumers.

Some firms may retain some of the cost savings in the form of increased profits. And in the postharvest sector, we have elements of both economic environments, depending on the commodity or the food product that we are talking about.

Labor and other input suppliers benefit from technologies. New technologies can foster increased labor productivity, allowing for increased wages and salaries without necessarily increasing retail prices. And the result can be a wider variety and more abundant supply of goods and services.

However, we do have to keep in mind that when more productive postharvest technologies are adopted, we do have some labor that could be replaced.

When we look at the benefits of this research and relate it back to funding, it raises another paradox that we have in this whole sector. As we indicated earlier, State appropriations now provide over half the expenditures for this research, which is a significant factor when we consider this relationship between beneficiaries and source of funding.

We found that the majority of the benefits for postharvest research go to those regions and States with high concentrations of population, except in the Northeast. Total benefits accruing to residents outside the region of the research that's conducted are at

least four times greater than the benefits to residents of this region.

So what this means is that taxpayers in major agriculture States, such as Illinois, where most of the postharvest research is conducted are, in effect, subsidizing postharvest research for consumers in the more populace but less-intensive agriculture State. There is increasing evidence to defend Federal support versus State support of postharvest research because for most postharvest technology development, the beneficiary is the U.S. public, generally, rather than any one State or region, as you get particularly—when you consider production agriculture. Many of those benefits go back to a region with a homogenous production base.

The last area that we want to talk about is basically the public and private sector research roles. We really have no fixed pattern that's ever been developed with respect to the kinds of research performed by either USDA, State agriculture experiment stations, and the private sector and no principle has been apparent in determining the role of each. Decisions as to where research is done in the public sector have invariably been decided ad hoc by discussion and agreement among concerned parties. Such decisions are frequently arbitrary, expedient, inconsistent from year to year and more influenced by pressures of the moment than by long-range guideline principles. This has been a major part of the debate between the executive branch and Congress in this area.

There is a role for both the public and the private research efforts in postharvest research. Both the public and private research participants make valuable contributions to the postharvest sector. However, if we can make roles more clearly defined, it should be possible for each to contribute more fully in their respective areas.

The private sector is motivated—and properly so—by market incentives. If management believes that the private rate of return will be substantial, resources are allocated for the research. Some distinguishing characteristics of private sector postharvest research need to be taken into account, though, when considering its role. One is that most private sector research tends to be focused on short-term applied problems.

Second, long-term inquiries to the biological, economic, and social systems would not tend to be supported by private sector research.

And, third, even though there may be substantial social benefits from private research, private industry, generally, is not concerned with the net social benefits from its research endeavors and is reluctant to release information that might cause technologies or processes they use to be adopted widely before they benefit from the economic return.

Thus, the areas of postharvest research that should primarily be in the private sector domain would include patentable processes and techniques, which is research that most nearly fits the short-term applied problems. Research to meet Federal and State regulations. In other words, research for business to stay in operation while meeting social objectives. And research to maintain or gain new clientele and/or market shares.

The public sector is justifiable for at least three reasons: Because benefits are distributed beyond those that bear the cost, substantial social advantages are derived from both public and private re-

search. And in the absence of public sector support and guidance, postharvest research might be biased strongly toward mechanical and chemical technologies, since economic returns can be extracted from them more easily in the short run.

And for those situations where the private research might be detrimental to industry competitiveness, a mix of public and private research, both basic and applied, may best preserve competition or reduce market power.

Thus, the areas of postharvest research that should be primarily in the public sector domain include basic knowledge or basic research, information to support policymakers, government action and regulatory agencies, so that informed decisions can be made.

And, three, research to enhance competition through a development of technologies and information that is disseminated to the public.

I want to thank you for inviting me to testify, Mr. Chairman, and I would be happy now or at a later time to try and answer any questions you might have.

[The prepared statement of Dr. Phillips follows:]

TESTIMONY OF MICHAEL J. PHILLIPS, Ph.D.

PROJECT DIRECTOR, OFFICE OF TECHNOLOGY ASSESSMENT

U.S. CONGRESS

Mr. Chairman and Members of the Committee:

Thank you for inviting the Office of Technology Assessment to appear before you today. I am Dr. Michael J. Phillips, the Project Director of the Technical Memorandum Agricultural Postharvest Technology and Marketing Economics Research. My purpose today is to summarize the findings of this report, which will provide an overview of this sector of the economy and the role of research.

We have faced for many years a very interesting paradox in the food and agricultural sector. The industrialization of American agriculture during the past decade has diminished farm numbers and farm population. While total agricultural production has increased, the input, finance, service, processing, transportation, and distribution industries surrounding production agriculture have become the dominant economic components of the food and agricultural system. The transformation of production agriculture from a major economic sector of the economy to minor status has been in progress since the founding days of the Republic. However, it has progressed rapidly in the post-World War II era via the technological revolution involving mechanical, chemical, biological, and managerial innovations on the farm. What has emerged from this process is a highly interdependent subsector of the U.S. economy for providing food and fiber for consumers at home and abroad.

Emphasis by agricultural scientists has been placed upon the technical, economic, and social aspects of production agriculture as the food and fiber system changed over time. However, in

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terms of value added, employment, contribution to gross national product, balance of trade, energy usage, and impact on inflation, the food and fiber system beyond the farm gate is approximately twice that of production agriculture.

Activities beyond the farm gate refer to the marketing or postharvest sector. Postharvest technology and marketing economics (PHTME) includes all technological and economic transformations that occur to agricultural products between harvest and consumption. PHTME encompasses storage, assembly, processing, packaging, warehousing, transportation, and distribution of agricultural products through institutional food trade and wholesale and retail outlets.

My testimony will cover four areas: 1) importance of postharvest sector to the national economy, 2) public investment in PHTME research, 3) benefits of PHTME research, and 4) role of public and private research sectors.

Importance of Postharvest Sector to National Economy

During 1982, Americans spent $298 billion for food. Approximately 30 percent of that went toward on-farm production costs, and the rest to postharvest activities. To appreciate the impact of the postharvest sector on the national economy consider the following facts:

- Consumer food expenditures have risen $183 billion since 1971, and increases in postharvest costs have accounted for 75 percent of that amount.
- The food and agricultural sector accounts for 22 percent of the total U.S. employment. Eighty-six percent or 20.5 million people are employed in the postharvest sector.

- The food and agricultural sector accounts for 20 percent of the Gross National Product. Almost 18 percent comes from industries in the postharvest sector.
- The food and agricultural sector consumes an estimated 17 percent of the total U.S. energy supply. Production agriculture consumes three percent, the postharvest sector 8 percent. (The remaining 6 percent is used in the home in preparing the food for consumption.)

The postharvest sector has also contributed to some of the economic problems facing the nation, particularly inflation and lagging productivity. Over the past decade, there has been a significant increase in consumer prices, and inflation in food prices has had a profound effect on the national economy. During the 1970's, food price inflation averaged 8 percent per year and accounted for an average of 26 percent of inflation in the general economy. Food price inflation peaked at 14.5 percent in the years 1973 and 1974, and it accounted for nearly 50 percent of the inflation in the general economy during those years. As indicated earlier, the postharvest sector accounted for 75 percent of the food price increases. Labor and energy have been the major components of these increases.

Productivity gains in the postharvest sector have been less dramatic than those achieved in farming. Most postharvest industries are afflicted with lagging or declining growth (Figures 1 and 2). The problem is especially evident in food transportation, food retailing, food service, and some food manufacturing industries.

Labor productivity growth rates in the food manufacturing sector vary considerably by industry. Although increases in labor productivity growth rates have occurred since 1972 in some industries (e.g., wet corn milling and soft drink manufacturing), in other industries (e.g., meatpacking, sugar, candy, and breakfast cereal), there has been no significant increases; in one industry (i.e., blended flour), productivity has actually declined.

In the food distribution sector, labor productivity growth rates in rail and truck transportation have not increased significantly since 1972. In retail food stores and in eating and drinking places, productivity now is significantly below 1958-72 levels. Lagging productivity growth in food processing and distribution sectors, in addition to contributing to lagging productivity in the general economy, has contributed to increased rates of food price inflation.

Investment in PHTME Research

Despite the importance of the postharvest sector to the national economy, relatively little attention is paid to it by the public research sector. Research expenditures, particularly by the Federal Government, for this sector have historically been low, but more importantly have not increased in real terms. In fact, a major debate annually between the Executive Branch and Congress is whether to provide any funding to this area of research. Executive Branch members, including USDA and the Office of Management and Budget (OMB), have taken the position that it is no longer necessary to invest in this research, the implication being that private firms have sufficient resources to conduct their own research.

Compared with production research, PHTME research has not been a major public sector priority. In 1981, $260 million or 18 percent of the combined research expenditures of USDA and State Agricultural Experiment Stations (SAES) went to PHTME research. Sixty-nine percent or almost $1 billion went to production research. **Further, public expenditures for PHTME research in constant dollars have increased only 1.6 percent between 1966 and 1981, and since 1978, have declined 8 percent.**

Analysis of USDA and SAES individual expenditures, however, show two different and distinct patterns. USDA constant dollar expenditures for in-house PHTME research and funds transmitted to SAES and other agencies decreased 17 percent between 1966 and 1981. Within USDA, Agricultural Research Service (ARS) declined by 20 percent and Economic Research Service (ERS) decreased by 10 percent during this period. In contrast, SAES expenditures for PHTME research increased by 32 percent in constant dollars from 1966-1981. Thus, by 1981 SAES had increased its share of the total public expenditures (SAES and USDA combined) for PHTME research from 38 to 51 percent of the total.

State appropriations to SAES account for the majority of funds for PHTME research. These appropriations increased from 43 percent to 56 percent of SAES funds for PHTME research. The Federal Government's share to SAES for PHTME research from 1966-1981 has declined from 53 percent to 38 percent. Thus, State appropriations comprise over one-half of the expenditures for PHTME research in the SAES.

PHTME Research Benefits and Beneficiaries

PHTME research provides a range of benefits including increased productivity and reduced real cost of food; enhanced food quality, safety, and nutrient content; new and improved food products; reduction in food losses due to waste; and information for decisionmaking.

PHTME research benefits can accrue to a number of beneficiaries, including:

- **Farm Producers.** -- By improving storage, processing, retailing, and transportation systems, postharvest technologies enhance the value of farm commodities by letting producers distribute the sale of products over time. Thus, farmers can obtain increased income by selling products off-season or in nonproducing areas. In addition, marketing services increase information available to producers, increasing their chances to sell at more favorable market prices.
- **Consumers and General Economy.** -- Technological changes in the postharvest or marketing sectors that reduce the costs of product transformation or marketing services can reduce retail prices for consumers. Similarly, consumers also can benefit from improved market or price information which leads to more informed decisionmaking. In addition, consumers benefit if food quality, nutrition, safety, and convenience are improved.

The distribution of PHTME benefits varies with income. OTA found that the ratio of consumer benefits to

family income was almost four times higher for the lowest income class than for the highest. In other words, the pay-off of PHTME research and technologies has a substantially greater beneficial impact on low-income consumers than on high-income consumers.

- **Marketing Firms.** -- Marketing firms also can benefit from PHTME research, depending on the competitive structure of the industry. In a competitive economic environment, firms that adopt more efficient and productive technologies might pass the savings on to consumers. This could provide a higher price for farm producers and lower retail costs for consumers. Some firms may retain some of the cost savings in the form of increased profits. The PHTME sector has elements of both economic environments depending on the commodity or food product.
- **Labor and Other Input Suppliers.** -- New technologies can foster increased labor productivity, allowing for increased wages and salaries without necessarily increasing retail prices. The result can be a wider variety and more abundant supply of goods and services. However, when more productive postharvest technologies are adopted, some labor may be displaced.

PHTME Research Benefits Related to Funding Source

As indicated earlier, State appropriations now provide over half the expenditures for PHTME research, which is a significant factor when considering the relationship between research beneficiaries and source of funding. OTA found that the majority

of benefits from PHTME research flow to those regions and States with high concentrations of population. Except in the Northeast, total benefits accruing to residents outside the region where the research is conducted are at least four times greater than the benefits to residents of the region. **Thus, taxpayers in the major agricultural States such as Illinois, where most of PHTME research is conducted, are in effect subsidizing PHTME research for consumers in the more populous but less intensive agricultural States.**

There is increasing evidence to defend Federal support versus State support of PHTME research because for most post-harvest technology development, the beneficiary is the U.S. public generally rather than any one State or region.

Public and Private Sector Research Roles

No fixed pattern has ever developed with respect to kinds of research performed by USDA, SAES, and the private sector, and no principle has been apparent in determining the role of each. Decisions as to where research is done in the public sector have invariably been decided ad hoc by discussion and agreement among concerned parties. Such decisions are frequently arbitrary, expedient, inconsistent from year to year, and more influenced by the pressures of the moment than by uniform, long-range guidelines or principles. This has been a major part of the debate between the Executive Branch and Congress.

There is a role for both public and private research efforts in PHTME research. Both the public and private research participants make valuable contributions to the PHTME sector.

However, with roles more clearly defined, it should be possible for each to contribute more fully in their respective areas.

The private sector is motivated by market incentives. If management believes that the private rate of return will be substantial, resources are allocated for research. Some distinguishing characteristics of private sector PHTME research need to be taken into account when considering its role: 1) most private sector research tends to be focused on short-term applied problems; 2) longer term inquiry into biological, economic, and social systems would not tend to be supported by private sector research; and 3) even though there may be substantial social benefits from private research, private industry generally is not concerned with the net social benefits from its research endeavors and is reluctant to release information that might cause technologies or processes they use to be adopted widely before they benefit from the economic returns.

Thus, the areas of PHTME research that should be primarily in the private sector domain, include: 1) **patentable processes and techniques** -- research that most nearly fits short-term applied problems; 2) **research to meet Federal and State regulations** -- research needed for a business to stay in operation while meeting social objectives; and 3) **research to maintain or gain new clientele and market shares.**

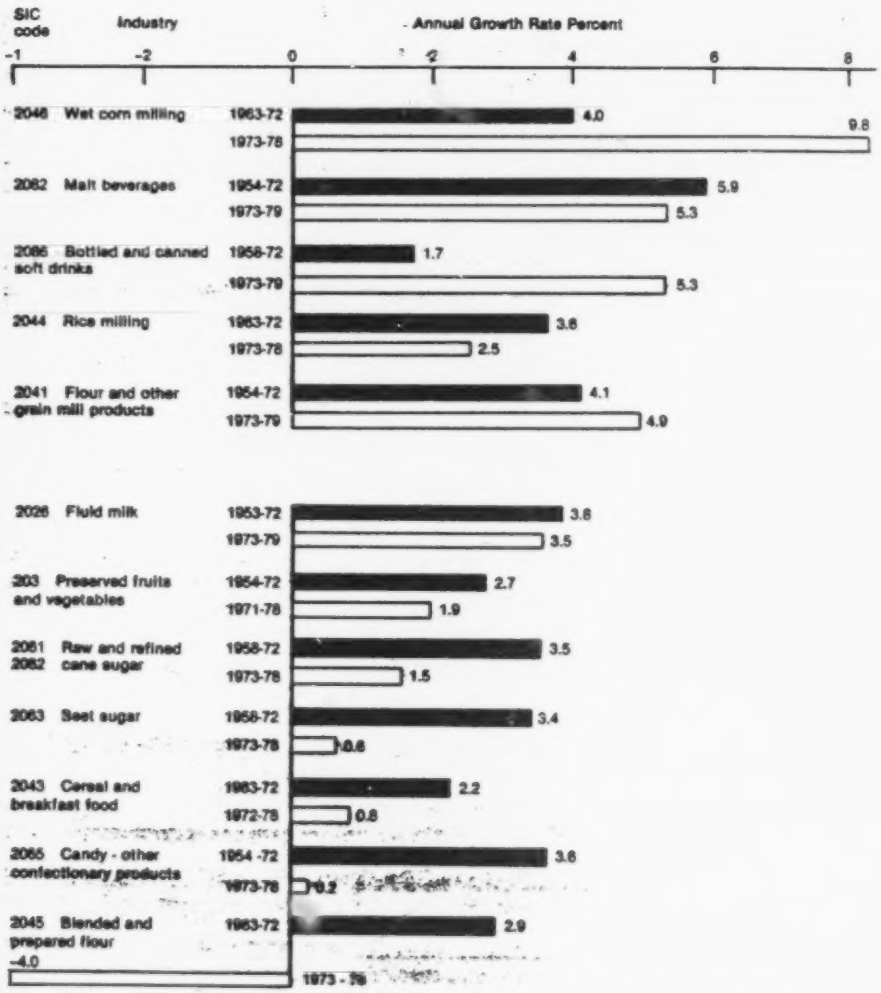
Public sector research is justifiable for at least three reasons: 1) because benefits are distributed beyond those who bear the costs, and substantial social advantages are derived from both public and private research; 2) in the absence of

public sector support and guidance, PHTME research might be biased strongly toward mechanical and chemical technologies, since economic returns can be extracted in the short run; and 3) for those situations where private reseach might be detrimental to industry competitiveness, a mix of public and private research, both basic and applied, may best preserve competition or reduce market power.

Thus, the areas of PHTME research that should be primarily in the public sector domain include: 1) **basic knowledge**; 2) **information to support policymakers and government action and regulatory agencies so that informed decisions can be made**; and 3)**research to enhance competition, through development of technologies and information that is disseminated to the public.**

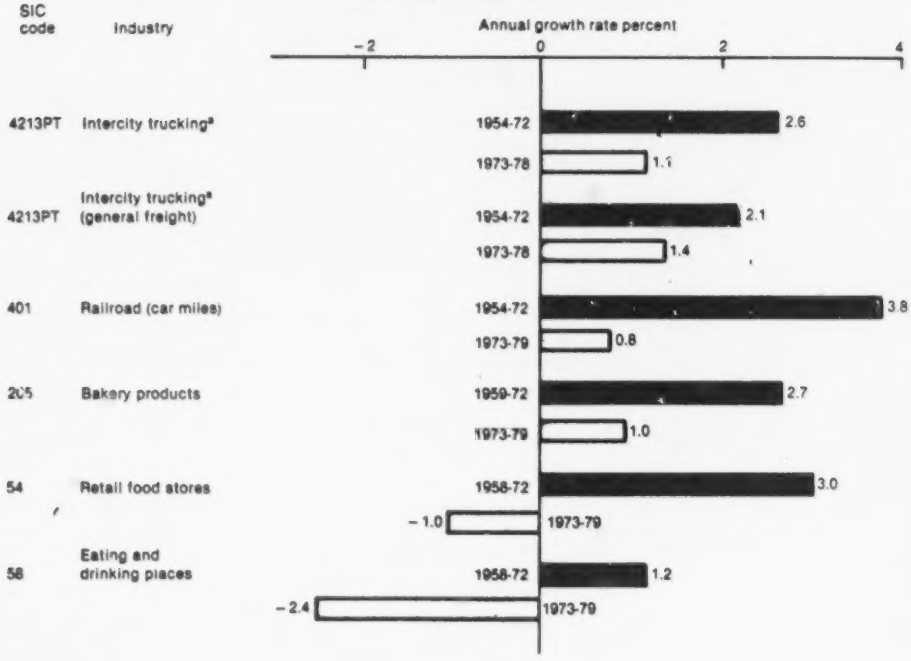
Thank you for inviting me to testify Mr. Chairman. I would be happy to try to answer any questions.

Figure 1.— Estimated Labor Productivity Growth Rates (output per employee hour) in the Food Processing Sector, 1954-72 and 1973-79



SOURCE: Bureau of Labor Statistics, *Productivity Indexes for Selected Industries, 1979 Edition*, Bul. No. 2054, December 1979 [Tiegen, 1981].

Figure 2.— Estimated Labor Productivity Growth Rates (output per employee hour) in the Food Distribution Sector, 1954-72 and 1973-79



[a]Output per employee.

SOURCE: Bureau of Labor Statistics, *Productivity Indexes for Selected Industries, 1979 Edition*, Bulletin No. 2054, December 1979 (Teigen, 1981).

Mr. DURBIN. Thank you, Dr. Phillips. We will hold the questions until Dr. Carter has had an opportunity to testify, and I would like to welcome Dr. Carter. I know there was a last minute switch and we are, indeed, fortunate today to have you here and we hope your flight connections were not too disturbing in making it out here to the Midwest.

Dr. Carter, as I mentioned earlier, is the Associate Administrator of the Agricultural Research Service, U.S. Department of Agriculture in Washington.

Dr. CARTER. Thank you very much, Mr. Chairman. I have submitted copies for the record and I will present, I think, pretty well what is in the testimony that I presented to you.

Mr. Chairman, other members of the committee and also other visitors there with you, I want to say that I appreciate the opportunity to appear before you and to discuss agricultural research and education activities in the postharvest area.

I am accompanied, by the way, Dr. Robert A. Rhodes, our Director from the ARS Northern Regional Research Center in Peoria. So if your questions get into some technical aspects of postharvest research, why, I hope it will be acceptable for me to call on him for some of the technical details that we might want to discuss later.

The science and education research expenditures in the postharvest program area in allocations to the Agricultural Research Service and also through Hatch and other funding mechanisms to the State experiment stations total about $120 million. I believe it safe

to conclude that such an expenditure would indicate that we do consider postharvest technology to be an important area of research.

It should also be noted at this point, I think, that there is a great deal of research in related areas which does have an impact on postharvest technology. Breakthroughs in biotechnology, in cell physiology, and other agricultural scientific areas ofttimes have a direct bearing on postharvest research phases.

Now, before moving on to the main portion of my testimony, I would like to take just a moment to comment on the private sector's role in postharvest technology. No one should assume that the public sector is working alone in its research. The private sector shares this responsibility. We interact on a constant basis with industry in the Agricultural Research Service and in the experiment stations. We exchange information and ideas, we share research results, we work together.

Now, research can be a catalyst for change, particularly in initiating new phases of corporate growth. It does so by generating new products and process concepts that can be developed into handsome, innovative technologies used by the industrial sector to produce new products or to increase the efficiency and profitability of existing processes.

New innovative technologies do not emerge from dedication of research resources to fine tuning existing processes and products. They emerge from putting together in unconventional ways pieces of useful technology from an expanding knowledge base. From the research and education view, we can contribute to stimulating a new growth phase in technology development for the postharvest agri-industry sector and other sectors.

We can do this by expanding the shrinking knowledge base and providing the data needed on which to base new technologies. To succeed, we must have our priorities clearly in order, we must be keenly aware of what we can do well and what others can do better. In short, we must use our human and physical resources wisely and efficiently.

We must also maintain a future orientation in our research because the chances that research can provide a quick fix in situations are slim. If it could, the industry would already be applying the technologies.

This means, then, that the research efforts are best sharply focused on areas where we have determined that lack of knowledge is clearly constraining technical advance and areas where positive contributions can be made to increase postharvest productivity and we must move to strengthen the competitive position of our agricultural products.

As this committee is aware, science and education's Agricultural Research Service has just completed its long-range agricultural research plan and its implementation plan for the next 6 years of its program. ARS is currently translating "implementation plan" into "operating plan" for its research laboratories.

In these plans, ARS independently came to generally the same technical conclusions as the Office of Technology Assessment reports. This ARS 6-year plan recognizes the deficiencies of past funding in the postharvest area and the need to allocate significant

additional resources for postharvest research, at least out to the 1990 boundary of the plan.

ARS expects to bring postharvest research from the current 18 percent of its total program to 21 percent by 1990, even assuming no real dollar funding increases for the agency, as a whole.

The State agricultural experiment stations have been increasing expenditures of funds derived from grants and cooperative agreements on postharvest research since about 1978.

Relative to the focusing of ARS resources in developing an expanded postharvest research program, we took into account production in excess of domestic needs, the need to lower production costs, and the need for products to more successfully compete in world markets, among other factors.

We also took into account in our planning the areas which we identified as being technically constrained by lack of fundamental knowledge. The plan which we emerged with selected a number of areas for increased emphasis in the coming years. A few of these are new approaches to reducing or eliminating microbial spoilage and insect attack on stored products and in transit; new technologies for innovative processing and conversion of commodities to add dollar value and open new markets; the elimination of insects and microbes which prevent export and decrease export value; new means to get precise control over agricultural product quality and resistance to deterioration; obtaining a better data base to predict preferences and direct research toward new consumer-oriented value-added products.

We take very seriously our responsibility to better coordinate and plan agricultural research across the spectrum of agricultural research performance. It is of high interest that the OTA report has clearly pointed out, that the only real increase in postharvest research in the State agriculture experiment station, for example, has been with funds provided by cooperative agreements and grants. We are also keenly aware of the value of the ARS program plan as a potential resource for coordinated planning in this area for the broader research community.

In the future, consumers will continue to expect new and different foods in food form. New products will emerge as consumers demand wholesomeness in food, more natural foods, more nutritious foods and more generic food products. Many households today are engaged in serious rethinking on how to use their available moneys, especially the food dollar. Increasing pressure for increased productivity and reduced real cost of food will provide the opportunity to improve processing technologies and increase marketing and distribution efficiency.

America has become a nation of urban dwellers who are increasingly dependent upon a highly developed technically oriented food delivery system.

In summary, Mr. Chairman, the message I want to deliver to you today in a very brief way is USDA science and education is aware of the underfunding situation for postharvest research and on its own impetus has taken steps to begin to rectify the situation within the limits of currently available resources.

Further, it is doing so in a very focused and efficient manner. The actions we have taken to increase funding of postharvest re-

search have not been without opposition but with the continued support of our administration and of the Congress which you represent, I believe we can make a contribution to strengthening the food processing and delivery sectors into a period of new growth for the industry.

We have already taken the first steps and are trying to convince our constituents of the correctness of the steps we have already taken, as well as our future plans.

Mr. Chairman, this concludes my prepared statement and I would be pleased to respond to any questions which you or your members would care to ask.

[The prepared statement of Dr. Carter follows:]

STATEMENT OF DR. MARY E. CARTER, ASSOCIATE ADMINISTRATOR, AGRICULTURAL RESEARCH SERVICE, U.S. DEPARTMENT OF AGRICULTURE

Mr. Chairman and members of the Committeee, I appreciate this opportunity to appear before you today to discuss Agricultural Research and Education activities in the postharvest area. I am accompanied by Dr. Robert A. Rhodes, the Director of the ARS Northern Regional Research Center in Peoria.

Science and Education Research expenditures in the postharvest program area in allocations to the Agricultural Research Service, and through Hatch and other funding mechanisms to the State Agricultural Experiment Stations, total approximately $120 million.

I believe it is safe to conclude that such an expenditure would indicate that we do consider postharvest technology to be an important area of research. It should also be noted at this point that there is a great deal of research in related areas which does have an impact on postharvest technology. Breakthroughs in biotechnology, genetic engineering and the other agricultural scientific areas often times have a direct bearing on the postharvest research phase.

Before moving into the main portion of my testimony, I would like to take just a moment to comment on the private sector's role in postharvest technology. No one should assume that the public sector is working alone in this research. The private sector shares in this responsibility. We interact on a constant basis with industry. We exchange information and ideas. We share research results. We work together.

Research can be a catalyst for change, particularly in initiating new phases of corporate growth. It does so by generating new product and process concepts which can be developed into "hands on" innovative technologies used by the industrial sector to produce new products, or to increase the efficiency and profitability of existing processes. New innovative technologies do not emerge from dedication of research resources to finetuning existing processes and products, which in general is where the research activity is now. They emerge from putting together, in unconventional ways, pieces of useful knowledge from an expanding knowledge base.

From a research and education view, we can contribute to stimulating a new growth phase in technology development for the postharvest agri-industry sector, and other sectors. We can do this by expanding that shrinking knowledge base and providing the data needed on which to base new technologies. To succeed at it we must have our priorities clearly in order, we must be keenly aware of what we can do well, and what others can do better. In short we must use our human and fiscal resources wisely and efficiently. We must also maintain a futures orientation in our research, because the chances that research can provide quick fixes in this situation are slim. If it could, the industry would already be applying the technology.

This means that the research efforts are best sharply focused on areas where we have determined that lack of knowledge is clearly constraining technical advance, and areas where positive contributions can be made to increase postharvest productivity, and to strengthen the competitive position of our agricultural products.

As this Committee is aware, Science and Education's Agricultural Research Service has just completed its long range agricultural research plan and its Implementation Plan for the next six years of its program. ARS is currently translating the Implementation Plan into a three-year operating plan for its research laboratories. In these plans, ARS independently came to generally the same technical conclusions as the Office of Technology Assessment Report.[1] This ARS 6-year plan recognizes

[1] Technical Memorandum: Agricultural Postharvest Technology and Marketing Economics Research, OTA, April 1983.

the deficiencies of past funding in the postharvest area and the need to allocate significant additional resources to postharvest research at least out to the 1990 boundary of the plan. ARS plans to bring post harvest research from the current 18 percent of its total program to 21 percent by 1990, even assuming no real dollar funding increases for the Agency as a whole. The State Agricultural Experiment Stations have been increasing expenditure of funds derived from grants and cooperative agreements on postharvest research since about 1978.

Relative to the focusing of ARS resources in developing an expanded postharvest research program, we took into account production in excess of domestic needs, the need to lower production costs and the need for products to more successfully compete in world markets, among other factors. We also took into account areas we identified as being technically constrained by lack of fundamental knowledge. The plan which emerged selected a number of areas of emphasis. A few of these are: new approaches to reducing or eliminating microbial spoilage and insect attack on stored products and products in transit; new technologies for innovative processing and conversion of commodities to add dollar value and open new markets; elimination of insects and microbes which prevent export and decrease export value; new means to get precise control over agricultural product quality and resistance to deterioration; obtaining a better data base to predict preferences and direct research towards new consumer-oriented, value added products.

We take very seriously our responsibility to better coordinate and plan agricultural research across the spectrum of agricultural research performers. It is of high interest that the OTA Report has clearly pointed out that the only real increases in postharvest research in the State Agricultural Experiment Stations, for example, has been with funds provided by cooperative agreements and grants. We are also keenly aware of the value of the ARS plans as a potential resource for planning in this area for the broader research community.

In the future, consumers will continue to expect new and different foods and food forms. New products will emerge as consumers demand "wholesomeness" in food; more "natural" foods, more nutritious foods, and more "generic" food products. Many households are engaged in serious rethinking of how to use available resources, including the food dollar. Increasing pressure for increased productivity and reduced real cost of food will provide the opportunity to improve processing technologies and increase marketing and distribution officiency. America has become a nation of urban dwellers who are increasingly dependent upon a highly developed, technically oriented food delivery system.

In summary the message I want to deliver to you today in a very brief way is that USDA's Science and Education was aware of the underfunding situation for postharvest research and on its own impetus has taken steps to begin to rectify the situation within the limits of currently available resources. Further it is doing so in a very focused and efficient manner. The actions we have taken to increase funding of postharvest research have not been without opposition. But with the continued support of our Administration and of the Congress which you represent, I believe we can make a contribution to strengthening the food processing and delivery sector into a period of new growth for the industry. We have already taken the first steps and are trying to convince our constituents of the correctness of the steps we have already taken as well as our future plans.

Mr. Chairman, this concludes my prepared statement. I will be pleased to respond to any questions you may have.

Mr. DURBIN. Thank you, Dr. Carter. I have some questions for both of you.

Dr. Carter, you have heard Dr. Phillips' testimony and probably have read his report relative to the shift of funding from the Federal to the State level in the past 17 or 18 years, in terms of postharvest research. Dr. Phillips suggests that this is not the best way to fund the type of research that is, in fact, resulting in national benefit.

You have indicated that you hope by 1990, under present goals, that the Federal level will increase in terms of total research from 18 to 21 percent.

Do you feel, in terms of the total amount that is being expended in this area, that it is an appropriate amount, relative to our na-

tional needs, and would you like to comment on the whole question of the State and Federal mix?

Dr. CARTER. Let's talk first about the agricultural research program, itself, and while I am not as intimately familiar with the specifics of the State experiment stations programs, we are glad to see them increasing and as I pointed out in my testimony, one of the ways they have been increasing is through cooperative agreements and grants from the Federal sector.

The basic research or data base that I referred to with regard to cell physiology, senescence in the ripening of fruits and vegetables of wheats and things of this sort, these are the types of data bases which contribute to postharvest technology, which are not actually classified as postharvest technology research, so that we have a continuum here in the Agricultural Research Service of many programs which will contribute in the long term to postharvest technology research.

Therefore, our projected increase in postharvest technology research with regard to transportation of products and what happens to them and the deterioration during transportation and in processing, we feel, is a reasonable target for increase.

Now, the second part of the question had to do with funding?

Mr. DURBIN. State versus Federal in terms of mix, and the total level of funding.

Dr. CARTER. I can only speak, of course, from the perspective with regard to percentagewise but in the overall agricultural sector, as pointed out in our agricultural ARS program plan, 53 percent of all the research in agriculture comes from the private sector. ARS only has a 9-percent portion of money spent in agricultural research. The States spend 16 percent. The funds that are allocated to the experiment stations through the Hatch Act also have a proviso in them, I believe, in which 25 percent of these moneys must be used in regional projects, funding of regional projects, and I feel that the States have done an excellent job in these regional projects. This is one of the areas in which they have increased some of that postharvest technology research, which is in the area of safety and health.

I think tremendous progress is being made and I feel that these areas are reasonably well funded, Mr. Chairman.

Mr. DURBIN. Dr. Carter, I would appreciate it if you would consider submitting that report which you made reference to, the ARS report, for the record.

Would that be possible?

Dr. CARTER. I would be delighted to submit the Agriculture Research Service program plan, as well as our implementation plan, which takes us to the 1990's. I also believe that if there is anyone in the audience that would like to have a copy immediately, that we do have some spare copies of this plan, which we could leave with them today.

Mr. DURBIN. Thank you.

Dr. Phillips, you've taken an overview of the whole situation.

Do you have any suggestions as to how we might coordinate private contribution and research, postharvest and State and Federal research contributions?

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Dr. PHILLIPS. Well, that has always been a very difficult thing to do but I think if you look back over history, some of the relationships that we've had between the public and the private sector, there have been times in our history where we've had better cooperation. Maybe that was before antitrust laws and this type of thing became so important.

But I think one of the ways in which we can get better public/private sector relationships is the continually working—particularly by the public sector—in encouraging the private sector to set up—through either their own trade associations or consortiums of companies—to establish things such as research committees. That used to be a type of thing that was done, particularly back in the 1950's. There were many research committees that were formed by professional societies, trade associations, many companies working together and they had a link, then, directly to USDA or to the State agriculture experiment stations.

That's not to say that there aren't many of those now but, relatively, they are not as important as they once were, and I think that's one of the real helpful links between the private sector and the public. The private sector, then, has a way in which they can bring to the public sector their concerns about what their problems are and some suggestions about the kinds of research that they feel they need some help from the public sector to develop technologies that can then help. I think that's a fairly promising way of handling such a situation.

Mr. DURBIN. We've had concerns expressed before the Science and Technology Committee from every industry imaginable concerning this type of joint venture approach, and cooperative approach, and we're now considering legislation in the committee. I appreciate your comments on that.

I might add, too, by way of comment rather than question, that I especially appreciate that portion of your testimony that's tried to bring together the various elements. I think many times we are feeling we are at war, the farmer is being blamed because food prices are high and he says, "That's not what I'm getting when I sell the product." And people tend to try to separate out each given section and assign a blame. We're all in it together. I think that, basically, is the message that I receive from your testimony.

If we're not increasing our market, if we're not increasing the availability of new processes, transport the processed food, then the loser is not only going to be the consumer, it's going to be the agricultural producer and across the board hurt our society. So I especially appreciated that.

Mr. Skeen.

Mr. SKEEN. Thank you, Dick.

Continuing along that same line—and I want to emphasize, too—it has been an overall problem with us in the Congress of the United States, first of all, in defining what everybody is doing out there.

For instance, in your discussions this morning, about the difference in the report from OTA and the ARS report, and so forth, they were in general agreement, but we have the feeling that there is really—when you speak of research and development, at any

technological level—but now let's just take it to the agricultural level, first of all in defining terms.

Research, the technological advance, and so forth, at the Federal level has a definition, an identity. At the local level, it becomes somewhat confused.

Then we went over to the private sector and you lose a great deal more. So there is a feeling, and I got from the sense of your discussions this morning, that there is a total lack of coordination, maybe in some general sense. But I just wondered if, for instance, the Department of Agriculture has any idea what's going on in the private sector, so far as private research and postharvest technology? Is there any summarization done, any effort, is this one of the priorities, at least just keeping track of what goes in the private sector?

Dr. CARTER. We keep track as best we can, Congressman, but you have to remember that private industry has a profitmaking mission and there is a limit to what they can share with us.

The best contact and the best way that we can keep up with their priorities is through communication, informal communication, visiting with them, which we do a great deal of on a personal basis, and also participating with the industry scientists at professional meetings and things of this sort.

In addition, we can rely on our Economic Research Service, in many instances, to, perhaps, help us in establishing some trends, and things of this type. But there is—one has to make a definite effort to find out what is going on in the industry and, of course, we've seen some increased communication in recent years with the changes in the patent laws of 1980. So I can say that we will be having more and more dialog with the industry people in the future, based on this change in the patent law.

Mr. SKEEN. That's one of our major concerns in Congress and I think the key words in there are technological transfer, joint venture associations, and avoiding antitrust provisions that we have tied ourselves to and which has worked to the disadvantage of a lot of technological development in the United States. As a matter of fact, some of the examples were fiberoptics. We developed them in the United States but we had to give them to the Japanese so we could buy it back from them. We are getting ourselves in our own way and I think there is a lot of duplication in agriculture in the postharvest technological area. I have a suspicion that there might be—and I don't know whether this is a strong feeling of Dr. Phillips because I think in his testimony he pointed this out—that it is not a well-coordinated activity at this point because of the provisions in the law. We would like to help smooth some of that up and encourage people to more closely coordinate these activities because it accrues to the benefit of the consumers.

Am I reading correctly?

Dr. PHILLIPS. Yes.

Mr. SKEEN. Thank you, Mr. Chairman.

Mr. DURBIN. Congressman Paul Simon.

Mr. SIMON. Yes; I was interested, Dr. Carter outlined some of the long range things that we ought to be looking at and, Dr. Phillips, you mentioned the need for long-range without getting too specific.

Dr. Phillips, if you were to pick three or four things that we ought to be working on, very specific things, long range, what would they be?

Dr. PHILLIPS. I think the major areas that you would want to concentrate on are long range in terms of more efficiency, in terms of the food processing sector, particularly the development of new foods, the new uses for foods, nonfood uses, in many cases. We have economic problems in terms of them not being efficient at the present time. But I think the whole area of nonfood uses for our food products, to make fuel, this type of thing, it's one that we have not emphasized that much in the past.

The other is really in the food distribution area, I would say, a real concern for the lack of productivity that we've had in our retail, our eating places, these types of things, we can do a much better job in terms of better food delivery, in terms of transportation systems, in terms of, particularly, the advantages that computers that are going to allow us, and robotics, in terms of warehousing that, in many cases, we're just scratching the surface of now. The electronic checkout is probably the most visible sign of technological advance.

In fact, I would go so far to say that in the distribution area, this electronic checkout is probably the major technological innovation in the last 20 years in the food retailing business. We've seen our food retail stores become larger and more self-service orientation. But there hasn't been that much in the way of technological development that help increase productivity. Electronic checkout is one of the most visible signs and I think that is going to help increase the productivity immensely. But there are many more things that can be done with the whole use of computer technologies and getting into the robotics area, in terms of warehouse design and those types of things, and we need to concentrate on them in terms of helping increase productivity.

Mr. SIMON. If I could follow through on that because I was startled a little—in view of the electronic checkout and some other things—you say in retail food stores and eating and drinking places, productivity now is significantly below the 1958–72 levels.

Now when you take the electronic checkout and the impact of the McDonald's and the Hardee's and the others at hand, obviously we're producing more hamburgers per hour than we used to, at least that's my impression, with the microwave. I'm a little startled by this. Are you sure this is accurate, No. 1, and what accounts for it if it is accurate?

Dr. PHILLIPS. Those figures, which are the latest data that are available, do not include the electronic checkouts because it has just now come onstream enough around the country, that the figures are in to compile that so, for the most part, electronic checkouts are not included in those figures and I think when they are included, you will see a bit of a turnaround.

And in terms of the fast food eating places, one of the things there is that, yes, McDonald's, Hardee's, are the first thing you think about but there are lot of other more not as well known or local franchises that have started up also, but are fairly marginal enterprises that tend to, with their long hours, they have tended to

bring some of the productivity gains down. That is what is behind some of the figures there for the fast food places.

Mr. SIMON. Thank you, Mr. Chairman.

Mr. DURBIN. Mr. Evans.

Mr. EVANS. Dr. Carter, I just have one concern. I think it's commendable that you're going to bring up postharvest technology research from 18 to 21 percent by 1990, but you go on to say even assuming no real dollar funding increases for the agency, as a whole. That leads me to question, without having seen the report, what you would cut if you didn't, in fact, get any real dollar increases and just a further comment or question, I would like to say that I think this area is worthwhile and since I sit on the Agriculture Committee, that we wouldn't mind seeing you come forward and maybe asking for some more money.

I guess an 18- to 21-percent increase of what you spend overall would be about $20 million, I assume, roughly. That's not a lot of money in the scheme of things for something that's so important. With Dr. Phillips commenting that States like Illinois are, in effect, subsidizing other States, we would like to see, I think, more of a Federal involvement in this area.

So I guess my question is, What gets cut and what stops you from coming maybe next year before the Agriculture Committee for an increase in this area?

Dr. CARTER. In our plan, we show that we do have some priorities. As we have stated—I don't know whether I stated this or whether Mr. Phillips here stated this—but in the agricultural sector, about in the high 40[1] percent of our research dollars has been going into other areas of research dealing with production and we are not properly addressing the losses that occur after the crop leaves the farm gate.

And so we could see that we need to redirect some of these moneys from actually producing the crop, perhaps, into making sure that what we produce really gets through the whole food system to the consumer and this is the way we would do the main redirecting.

We also see a great need for increasing our research in our natural resource area, to some extent, that we must maintain that base to continue to produce food for the people of this country and for export. So that is the way we would do this.

Mr. EVANS. You're reluctant to come before the committee and ask for more? I know we have deficit problems but it seems to me that postponing the increase or phasing in the increase from 18 to 21 percent may stop real development of this program now and, since I think many people have related the growth of research in this area to help in expanding agricultural postharvest economy, I think it might be worthwhile now that we put some money in.

Dr. CARTER. We are steadily, perhaps too slowly, increasing our asking the Congress for moneys in this arena.

For example, between 1982 and 1983, we have added essentially an additional $2 million to this area, and this was in our budgeting process, asking for an increase here. Also, in our 1984 budget, we're

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[1] Letter dated Sept. 30, 1983, from M. E. Carter, requesting change from 60 percent to 40 percent.

asking for an even greater increase in postharvest technology research.

Mr. EVANS. Thank you.

Mr. DURBIN. I want to thank both members of the panel for giving us an excellent overview to start the proceedings this morning.

Dr. Phillips and Dr. Carter, thanks for coming out from Washington. We appreciate your coming and I hope your trip back is less eventful than the one out.

Our second panel I would like to invite up to the stage at this point is the private sector viewpoint and representing some local areas of businesses which are involved in postharvest technology: Dr. Richard Hahn, vice president of research, A. E. Staley Manufacturing Co.; Dr. John Long, vice president of research, ADM, Inc., Decatur; and Neil Pfieffer, president, Global Foods, Mount Zion, Ill.

Gentlemen, we would like to encourage you to summarize or condense your remarks. We can guarantee you that your entire statement will be placed as a matter of record at this hearing. I would like to start with Dr. Hahn, of A. E. Staley.

STATEMENTS OF DR. RICHARD HAHN, VICE PRESIDENT, RESEARCH, A. E. STALEY MANUFACTURING CO., DECATUR, ILL.; DR. JOHN LONG, VICE PRESIDENT, RESEARCH, ADM, INC., DECATUR, ILL.; AND MR. NEIL PFIEFFER, PRESIDENT, GLOBAL FOODS, INC., MOUNT ZION, ILL.

Dr. HAHN. Thank you, Congressman Durbin, and other members of the subcommittee, I am Dick Hahn, vice president of research at A. E. Staley Manufacturing Co. here in Decatur. We're pleased to be called upon to comment on the role of technology in agriculture, specifically the development of postharvest technology in our vision of the future.

Let me briefly describe the Staley Co. We are a major processor of corn and soybeans. Our business basically is to convert the Midwest's two leading crops, corn and soybeans, into value-added products of greater utility. To achieve our place of leadership in these businesses, Staley has chosen to invest heavily in research and development.

The Staley Research Center here in Decatur provides over 100,000 square feet of laboratory space and 50,000 square feet of pilot plant for 150 researchers. Our research budget is in excess of $10 million. A major portion of our research effort is devoted to development of new agribusiness technology. We are proud of our technical leadership in our chosen areas of business and we rely on technical and engineering expertise to provide us with products that have economic and functional advantages in the marketplace.

Our research and development program is a well-balanced blend of short, intermediate, and long-range initiatives, designed to improve our two technologies, while exploring the most likely alternatives. We must be constantly alert to the possibilities of shifting to new processes, as well as continuing implemental improving of existing ones.

The basic challenge of our research is management of technology. Leadership in research and development will supply the com-

petitive edge to the businesses which stimulates growth. Growth, in turn, stimulates reinvestment in research and this cycle renews.

To make that technology happen requires careful consideration of three different factors: First of all, is the basic knowledge available? Basic research is the basis on which we must work. What do we already know, what is the likelihood of improving it, do we know where to look? Frequently, the basic research is not found in the agricultural sector. We have to look elsewhere.

Second, research and development takes time. Are we patient enough to invest in it for what is likely to be an extended period? Many discoveries require in excess of 20 years to mature. Support must be consistent. Research can't be turned off and on and expect to be productive.

Third, what are the economic and competitive risks associated with technological creativity? What are the rewards? Research is expensive and it is risky and is there a hope for a reasonable payback on this investment?

Now, to illustrate the commitment required to undertake development and profitable commercial utilization of new technology, I would like to describe some recent Staley experiences in this postharvest area.

In 1968, Staley, at that time, was a leading producer of corn syrups, acquired the right to use a process employing a Japanese enzyme called Isomerase. This enzyme converted dextrose to fructose and, for the first time, presented the corn refiners an opportunity to create corn sweeteners with the sweetness of sugar.

At that time, Isomerase was a laboratory curiosity although it required 15 years of research to bring it to that point. It took Staley another 4 years of development to achieve initial commercial production and 3 to 4 years to achieve commercial acceptance.

Now, the introduction of high-fructose corn syrup not only signified an achievement based on a major investment in technology, but it also occasioned some very meaningful economic progress. First of all, it provided the opportunity for considerable U.S. sweetener self-sufficiency, provided by domestically produced sugar in corn.

Second, it benefited the American consumer by stimulating domestic sweetener competition.

Third, it created a whole new market for the American farmer and, finally, it contributed to favorable U.S. balance of trade by reducing sugar imports and increasing coproduct exports.

I think, possibly the most meaningful to our discussion here today that contributed earnings to our industry, which has been reinvested in the development of new corn-based products. I think I must point out also that because the United States did not invest early in the basic research in this technology, some of the benefits of this have accrued to Japan, Europe, and so forth.

The second revolution in food technology is also underway and you'll hear more about this from my colleagues here, and this is the food uses of soy protein, which shows great promise. We are working to deliver the right combination of economics, functionality, nutrition, and flavor and a wide variety of soy foods are gradually penetrating to the major markets. Educating consumers to the nutritional value in the culinary flexibility of soy protein is

the challenge well worth accepting. Soon we may all be eating and enjoying soy and, in fact, many in this room will have an opportunity to do so today.

Great opportunities exist for developing uses of corn and soybeans beyond food and beverages. The pure alcohol from corn starch is an example of this.

But a closely related and even more promising market, however, is that resulting from the Staley Research in the production of chemicals from carbohydrates, the creation of starch-based products to replace petrochemicals. Staley has invested considerable resources in nearly 20 years of developing this technology. And, today, chemicals from carbohydrates are no longer a long-term dream.

A new Staley plant in Arkansas is now in operation using corn starch to produce chemicals from carbohydrates at a rate of 30 million pounds, annually. Our new starch-based methyl glucoside is currently being used by several companies to make insulation foams, coatings, adhesives, and paints.

Other commercial applications for chemicals include use in surfactants, oil well additives, textiles, papers, and chemical intermediates.

Our Arkansas plant, however, is considered only an interim facility, inasmuch as market potential for our chemicals is several billion pounds annually, so although the program is only in a formative stage, it could become as meaningful to our industry as high-fructose corn syrup has been.

Just because the technology is possible or available, does not guarantee its economic success. The success of chemicals from carbohydrates depends heavily on the relative price of petroleum feedstocks with which they compete.

Similarly, aside from environmental concerns regarding lead, there would likely not be an ethanol market today if petroleum exporters had not combined to set oil prices at current or even higher levels.

Fortunately, companies like Staley have been sufficiently positioned technologically to take advantage of external developments such as these.

Applying technology to convert grain from chemicals, food products, and other commercial materials is an extremely capital-intensive undertaking and energy-intensive, as well. It is apparent that our industry must find ways to reduce the capital costs associated with employing new technologies or we may be unable to take advantage of future developments with any reasonable expectation of success.

Government can play an important role. Basic research, the foundation from which creative technology springs, must be vigorously supported. A new partnership between institutions of higher learning and private industry is already being forged and will, no doubt, continue. Public funding for basic research in our universities, however, must not be allowed to diminish. In fact, increased research emphasis on a broad range of both pre- and post-harvest fields of study should produce impressive results.

These fields of study include genetic engineering, fermentation and biotechnology, separation technologies, engineered foods, and hydroponics, to name just a few.

Basic research is also needed to reduce the capital investment through process simplification. Methods must be found to reduce the cost of applying state of the art biochemical and chemical technologies to commercial uses.

Moreover, the development of more energy-efficient processes, most associated with separation and/or isolation of product, are essential to reducing the energy-intensity of our industry. Energy consumption can be reduced through the use of enzyme-catalyzed reactions already being applied but an area in which continued developmental efforts are likely to bear fruit.

Staley has invested heavily in computer technology. Our new processing plants are all completely computer controlled, which has greatly increased our productivity.

Not only must public funding be provided for basic research in agricultural technology, we must not overlook the fundamental component of a successful research formula: The quality training of scientists and technical personnel whose creativity and imagination are the key to technological progress.

In my remarks, I have attempted to emphasize that the dynamic technological development achieved by our industry in recent years would have been impossible without the expectations of an attractive return on capital investment.

Fortunately, our technical investments have been rewarded. This vital profit incentive must not be eroded. The technical possibilities for increased utilization of grain are many but economics, ultimately, will be the deciding factor.

Public policy regarding economic development, taxation, regulatory and licensing practices and international trading relationships must take into account the risks associated with making technology happen.

We are competing with countries where research has a national priority. The costs associated today with supporting research and development, constructing plants and facilities and developing markets are prohibitive, absent the fundamental expectation of a return on investment.

At Staley, we believe that careful coordination of research and development activities with business strategy and performance enable us to manage technology effectively and profitably. After all, the technologies we investigate today hold the promise of new products, new markets tomorrow for our farmer colleagues, consumer friends and that's the formula for progress.

This concludes my prepared remarks. I would be pleased to answer any questions.

[The prepared statement of Dr. Hahn follows:]

TESTIMONY OF DR. RICHARD R. HAHN, VICE PRESIDENT, A. E. STALEY MANUFACTURING CO.

Thank you, Congressman Durbin and other members of the subcommittee.

I'm Dick Hahn, vice president for research and development for the A. E. Staley Manufacturing Company here in Decatur. We are pleased to be called upon to comment on the role of technology in agriculture; specifically, the development of post-harvest technology and our vision for its future.

Let me begin by briefly describing the Staley Company. We are a major corn refiner and a leading soybean processor. We operate five corn plants and six soybean mills throughout the nation.

Our business is basically to convert the midwest's two leading crops—corn and soybeans—into "value added" products of greater utility. To achieve our place of leadership in these businesses, Staley has chosen to invest heavily in research and development. The Staley Research Center here in Decatur provides over 100,000 square feet of laboratory space and 50,000 square feet of pilot plant facilities for a staff of 150 scientists. A major portion of our research effort is devoted to the development of new agri-business technology—designed to create new product concepts from renewable resources for new markets. We are proud of our technical leadership in our chosen areas of business and we rely on technical and engineering expertise to provide us with products that have economic or functional advantages in the marketplace.

Our research and development program is a well-balanced blend of short, intermediate and long-range initiatives, designed to improve our key technologies while exploring the most likely alternates. We must be constantly alert to the possibilities of shifting to new processes as well as continuing the incremental improvement of existing ones.

A basic challenge in Staley research, therefore, is the management of technology. This management starts with the careful coordination of research and development efforts to the growth plans of corporate business units. Research can supply the new technologies, new products and technical support necessary to maintain the growth and vitality of the Company's chosen business areas. Optimally, leadership in research and development will supply the competitive edge to the business unit which stimulates growth; growth, in turn, stimulates reinvestment in research, and the cycle renews.

Making technology happen, however, requires careful consideration of a number of factors:

(1) Is the basic knowledge available from which to launch a technological development; i.e., what do we already know and what is the likelihood of improving on it; do we know where to look?

(2) Research and development takes time; are we patient enough to invest in it for what is likely to be an extended period; are we committed?

(3) What are the economic and competitive risks associated with technological creativity; what are the rewards; is there a reasonable hope for a payback?

To illustrate the commitment required to undertake the development and profitable commercial utilization of a new technology, I need only describe some recent Staley experiences.

In 1968, Staley, even then a leading producer of corn syrups, acquired the right to use a process employing a new Japanese enzyme called Isomerase. This enzyme converted dextrose to fructose and, for the first time, presented the opportunity for corn refiners to create corn syrups with the sweetness of sugar. At that time, Isomerase was still a laboratory curiosity which had already required fifteen years of basic research. It took Staley yet another four years of development effort to achieve initial commercial production of high fructose corn syrup.

The introduction of high fructose corn syrup not only signified an achievement based on a major investment in technology, but it also occasioned some very meaningful economic progress: it provided the opportunity for considerable U.S sweetener self-sufficiency provided by domestically produced sugar and corn; it benefited the American consumer by stimulating domestic sweetener competition; it created a whole new market for the American farmer; it contributed to a favorable U.S. balance of trade by reducing sugar imports and increasing coproduct exports; and, possibly most meaningful to our discussion here today, it contributed earnings to our industry which have been reinvested in the development of new corn-based products.

Since those early days, hundreds of millions of dollars have been invested in plant capacity and in developing new applications to assure continued growth. Now, after little more than a decade of commercial availability, nearly half of the 125 pounds of sweetener consumed by every American, every year is derived from corn; most of it high fructose corn syrup.

Staley alone can produce over 3.5 billion pounds of high fructose corn syrup and more than 1 billion additional pounds of regular corn syrups and dextrose annually. Today, after hundreds of millions of dollars and some 35 years of technological development, consumers join the sweetener revolution with every sip of a soft drink, every serving of bread and jam and through the consumption of virtually hundreds of other foods and beverages.

A second revolution in food technology is also under way. Though you'll hear more about this from my colleagues here today, foods uses of soy protein hold great promise for companies like Staley. We are working to deliver the right combination of economics, functionality and flavor and have already developed a wide variety of soy foods which are gradually penetrating major markets. Educating consumers to the nutritional value and culinary flexibility of soy proteins is a challenge well worth accepting. Soon, we may all be eating and enjoying soy; in fact, many in this room will have an opportunity to do so today.

Great opportunities exist for developing uses for corn and soybeans beyond food and beverages. One example, of course, is ethanol or power alcohol from corn starch for use in motor fuels. Ethanol was originally employed as a gasoline extender to help us reduce our dependence on imported oil. Today, however, this product is emphasized more as an octane enhancer for gasoline, replacing lead. As we swing away from leaded fuels, the demand for ethanol-fortified fuels will rise.

A closely related but even more promising market, however, is that resulting from Staley research in the production of chemicals from carbohydrates—the creation of starch-based products to replace petrochemicals. Staley has invested considerable resources and nearly 20 years in developing this technology and today chemicals from carbohydrates are no longer a long-range dream.

A new Staley plant in Arkansas is now in operation using corn starch to produce these chemicals from carbohydrates at a rate of 30 million pounds annually.

Our new starch-based methyl glucoside is currently being used by several companies to make insulation foams, coatings, adhesives and paints. Other commercial applications for chemicals from carbohydrates include use in surfactants, oil well drilling muds, and in new food starches.

Our Arkansas plant, however, is considered only an interim facility inasmuch as the market potential for our chemicals from carbohydrates amounts to several billion pounds annually. So, while the program is only in its formative stages, it could become as meaningful to our industry as high fructose corn syrup has been.

Just because the technology is available or possible, however, does not guarantee its economic success. The success of chemicals from carbohydrates, for example, depends heavily on the relative price of the petroleum feedstocks with which they compete. Similarly, aside from the environmental concerns regarding lead, there would likely not be an ethanol market today if petroleum exporters (OPEC) had not combined to set oil prices at current or even higher levels.

Fortunately, companies like Staley have been sufficiently positioned technologically to take advantage of external developments such as these.

Applying technology to convert grain into chemicals, food products and other commercial materials is an extremely capital- and energy-intensive undertaking, however. It is apparent that our industry must find ways to reduce the capital costs associated with employing new technologies or we may be unable to take advantage of future developments with any reasonable expectation of economic success.

Government can play an important role. Basic research, the foundation from which creative technology springs, must be supported vigorously. A new partnership between institutions of higher learning and private industry is already being forged and will, no doubt, continue. Public funding for basic research in our universities, however, must not be allowed to diminish. In fact, increased research emphasis on a broad range of both pre and postharvest fields of study should produce impressive results. These fields of study include genetic engineering, fermentation and biotechnology, engineered foods (foods through chemistry) and hydroponics, to name a few.

Basic research is also needed in process simplification. Methods must be found to reduce the cost of applying state-of-the-art biochemical and chemical technologies to commercial uses. Catalysis in carbohydrate reactions, new recovery processes, and development of concentrated fermentation chemicals are some of the ideas for reducing capital investment through process simplification. Moreover, the development of more energy efficient processes—most associated with separation and/or isolation of the product—are essential to reducing the energy intensity of our industry. Energy consumption can be reduced through the use of enzyme catalyzed reactions, already being applied but an area in which continued developmental efforts are likely to bear fruit.

Not only must public funding be provided for basic research in agricultural technology, but we must not overlook a fundamental component of a successful research formula: the quality training of scientists and technical personnel whose creativity and imagination are the key to technological process.

In my remarks, I have attempted to emphasize that the dynamic technological development achieved by our industry in recent years would have been impossible without the expectation of an attractive return on capital invested. Fortunately, our

technical investments have been rewarded. This vital profit incentive must not be eroded. The technical possibilities for increased utilization of grain are many, as I've suggested, but economics utimately will be the deciding factor.

Public policy regarding economic development, taxation, regulatory and licensing practices, and international trading relationships must take into account the risks associated with making technology happen. The costs associated today with supporting research and development, constructing plants and facilities, and development markets are prohibitive, absent the fundamental expectation of a return on the investment.

At Staley, we believe that careful coordination of research and development activities with business strategy and performance enables us to manage technology effectively and profitably.

After all, the technologies we investigate today hold the promise of all new products for new markets tomorrow. From our farmer colleagues to our consumer friends, that's a formula for progress.

This concludes my prepared remarks. I would be pleased to answer any questions you may have. Thank you.

Mr. DURBIN. Thanks, Dr. Hahn. We will finish the testimony and open up the questions to the panel.

Dr. Long.

Dr. LONG. Thank you, gentlemen.

Gentlemen, ADM has the following comments for the Subcommittee on Investigations and Oversight on the subject of postharvest research and economics.

Now, this is an important subject for the agricultural consumer and other communities within the world economy.

My comments are going to be confined to the soybean, fuel ethanol from renewable sources and hydroponics. I'd like to say also it is difficult to separate the postharvest part of the industry from the basic area of genetic engineering, plant breeding, etcetera. There are some undesirable characteristics in various agricultural raw materials that require expensive processing to obtain the desired end product. If the undesirable characteristics of the raw material were eliminated, processing would cost less and better economics would evolve.

Several of the thoughts that I will discuss are not new and some are subjects of research in industrial companies, universities and private and Government laboratories. However, this does not say that adequate resources have been applied.

ADM works very closely with all of the various Government and our suppliers, research laboratories. We feel in this manner, this cooperation, leads to new products, new processes, new equipment quicker than maybe the closed research systems that some organizations may run. So we try, as best we can, to eliminate this not—admitted—here factor.

We all know that soybeans are a major U.S. crop. There were about 68 million acres planted in 1981, and over 2 billion bushels were harvested. This had a farm value in excess of $14 billion.

Over 1 billion bushels were crushed in the United States for oil and feed and this was also one of our major export crops. Soybeans are grown in many parts of the United States but the major States are Illinois and Iowa. Together, they grow about 35 percent of the entire crop.

I'd like to give two or three very explicit examples of how basic research might improve postharvest economics.

For example, increase in the sulfur amino acids in soy protein. This now limits the growth of poultry and swine. To maximize the

growth, one must blend in amino acid methionine or other feed ingredients. For human consumption, the methionine makes it difficult to use because it gives undesirable flavor. So it would be beneficial if the high sulfur amino acids could be branded to the bean.

Increasing the level of stachyose and raffinose sugars would be desirable because they, in general, cause flatulence. This limits the food value of soy protein to various people. Again, in current operations, the sugars are removed by expensive washing techniques when soy concentrates or isolates are made. Again, basic research might eliminate these sugars.

The flavor instability of soy oil: Soy oil is the major edible oil in the United States. Nine billion pounds are consumed a year. However, it is not as stable as some food oils because it contains high levels of linolenic acid. To overcome this, we must hydrogenate the oil. Basic research could decrease this level and it might eliminate some of the hydrongenation and this would lower the postharvest costs.

There are various antinutritional factors in soybeans, which interfere with the digestive processes in humans and animals. These are largely inactivated by heating during processing. This heat, if not controlled, can decrease the nutritional value of the soy protein. Again, can this be eliminated?

As far as postharvest research, soy flours, concentrates and isolates are consumed by humans. Generally, they are blended with other food ingredients. These blends give excellent nutrition, less calories, less cholesterol and considerably lower costs. More research is needed on food formulation, as well as consumer education so the consumer will better accept these products.

Again, the soy industry is so large, that a very small savings per bushel would give considerable economics. Research on energy savings is worthwhile. An example is the USDA program where they are using CO^2 to extract oil from soybeans, the super critical liquid phase. Maybe in the years ahead, this will be beneficial.

Switching now to fuel grade thanol, ADM has pioneered the production of fuel grade ethanol from corn starch. Corn is still the best renewable source, although we must continually evaluate other raw materials.

The ethanol industry started in 1978, and today produces in excess of 1 million gallons per day. About 2½ gallons of alcohol is attained from a bushel of corn. This means over 500,000 bushels of corn are utilized daily. Corn starch is converted to alcohol and the valuable byproducts of protein and oil are used for human and animal food.

This industry has made tremendous technical progress in just 5 years. The energy consumption to make alcohol is about 25 percent of what it was 5 years ago.

Technically, ethanol is an excellent fuel because it is an octane booster. It is one of the best octane boosters in the gasoline trade and now the refineries are buying it directly to incorporate in the refinery to get the desired octane and to increase the yields from crude oil.

Ethanol eliminates the need for lead in gasoline and this can contribute to the health of the Nation. Although much has been accomplished, some specific things need to be done. For example, im-

proved yeasts, which would give higher alcohol yields at higher temperatures with lower operating costs. Genetic engineering or protoplast fusion studies can be done.

Conversion of CO^2 into other chemicals: In the production of ethanol, one half of the weight of the sugar is converted to alcohol and one half to CO^2. The CO^2 portion is either lost to the atmosphere or recovered and used as a coolant, which is a very low-value item. A major breakthrough would be accomplished if an economical route could be found to convert the CO^2 to ethanol or in some way see that the CO^2 is not formed or the CO^2 could be converted to another high-value chemical. This would dramatically lower the ethanol cost.

There is much research that's been done on the use of plant waste such as cellulose from trees, agricultural plant waste. Nothing on the horizon is really commercially feasible at this point. However, this work should continue.

Switching now to hydroponics, ADM again has pioneered this industry in the Midwest with respect to utilization of waste heat from a processing plant to warm the growing crops in cold weather. About 40 percent of the total production cost in the winter is heat. Historically, growing vegetables in the Midwest has not been economically feasible. However, rising costs of transportation from traditional growers in the Far West and Southwest has made Midwest vegetable production a concept worth considering.

At ADM, the utilization of existing energy sources and byproducts brought about this concept. ADM has 2½ acres under roof and an additional 2 acres under development. Vegetables are grown in water with 24 nutrients adding to stimulate and promote plant growth.

In the ADM operation, waste heat from the corn plant is brought in and helps to reduce utility costs by 90 percent. Water at 160° is piped to the greenhouse in a closed route. On return, the water will have cooled to 120°. The water heats the greenhouse and warms the nutrient solutions, as well.

Carbon dioxide thrown off during the fermentation stage in the production of fuel alcohol is piped to the hydroponics operation to help increase and stimulate plant growth. A greenhouse of cucumbers can use all the available CO^2 in a house in 15 minutes. By raising the level of CO^2 to 340 parts per million to 1,200 parts, plant yields can be increased by 20 to 40 percent. The use of waste heat and carbon dioxide are factors that could make hydroponics a cost-efficient operation.

Hydroponics is still an experimental operation. If commercially successful, it could open a large, new industry in the Midwest because there are many processing and utility plants that have waste hot water.

However, much research is needed. Just a couple of examples here: Better seeds are needed which should be specifically developed for hydroponics. This could develop higher yields in shorter periods of time. There needs to be considerable engineering research. The plant growing and harvesting steps need to be further mechanized. Otherwise hand labor can be prohibitive.

This concludes my comments and, again, I would be happy to answer any questions.

[The prepared statement of Dr. Long follows:]

COMMENTS FROM ARCHER DANIELS MIDLAND CO., JULY 25, 1983, by JOHN E. LONG, PH.D., DIRECTOR SCIENTIFIC AFFAIRS

Gentlemen, ADM has the following comments for the Subcommittee on Investigation and Oversight on the subject of Post Harvest Research Technology and Economics. This is an important subject for the agricultural, consumer and other communities within the world economy.

My comments will be confined to the soybean, fuel ethanol from renewable sources and hydroponics area. Let me also say it is difficult to separate the post harvest part of the industry from the basic area of genetic engineering, plant breeding, etc. There are some undesirable characteristics in various agricultural raw materials that require expensive processing to obtain the desired end product. If the undesirable characteristics of the raw material were eliminated, processing would cost less and better economics would result to all.

Several of the thoughts given below are not new. Some are not the subject of research in industrial companies, universities and private and government research laboratories. However this does not say that adequate resources are being applied.

SOYBEANS

As we all know soybeans are a major U.S. crop. In 1981 about 68 million acres were planted and a little over 2 billion bushels were harvested. This had a farm value of over $14 billion. Over one billion bushels were crushed in the U.S. for the oil and meal. Also this one of our major export crops with over 800 million bushels shipped in 1981. Soybeans are grown in many parts of the U.S. but the major states are Illinois and Iowa. Together they grow about 35% of the entire crop. Indeed it is important to the Midwest.

Soybeans are one crop where basic research could benefit post harvest economics.

Increase the level of sulfur amino acids

The sulfur containing amino acids are the limiting ones in soy protein. This limits the growth rate of poultry and swine. To maximize growth one must supplement the soy with the amino acid methionine or blend in other feeds from corn and wheat. For human consumption the addition of methionine can be difficult because it does add undesirable flavors. However, when methionine is added the PER is almost as good as milk protein. Milk protein is the standard for human feeding.

It would be beneficial if a higher level of sulfur amino acids could be bred into the bean.

Decrease the level of stachyose and raffinose

The sugars stachyose and raffinose are claimed to cause flatulence. This limits the soy food value for people who are especially sensitive to the problem. In current operations the sugars are removed by expensive washing techniques when soy concentrates or isolates are made.

Again basic research might eliminate these sugars from the bean.

Improved flavor stability of soy oil

Soy oil is the major edible oil in the U.S. (about 9 billion pounds is consumed per year). However it is not as stable as some food oils because it contains high levels of linolenic acid. To overcome this flavor defect we must hydrogenate the oil.

Basic research might decrease the linolenic level and eliminate the problem. this would lower post harvest costs.

Elimination of anti-nutritional factors

There are natural occurring components of the bean that negatively affect the degestive process in humans and animals. They are largely inactivated with heat during processing. This heating, if not controlled, can decrease the nutritive value of the soy protein.

Can a bean be developed that contains little or none of these anti-nutritional factors?

There are some areas specific for post harvest research.

Research on the use of soy protein in human foods

Soy flours, concentrates and isolates are consumed by humans. Generally they are blended with other food ingredients. These blends give excellent nutrition, less calories, less cholesterol and considerable lower cost.

More research is needed on food formulations as well as consumer education. The latter is needed to increase consumer acceptance.

Research to lower the processing cost

The soy industry is very large so a small savings per bushel gives considerable economics. Research on energy savings is worthwhile. An example is the research program to extract oil from beans with CO^2 (super critical liquid).

FUEL GRADE ETHANOL FROM RENEWABLE SOURCES

ADM has pioneered the production of fuel grade ethanol from corn starch. Corn is still the best renewable source although we must continually evaluate other raw materials.

The ethanol industry started in 1978 and today produces in excess of one million gallons per day. About 2.5 gallons of alcohol is produced per bushel of corn. This means about 500,000 bushels of corn are utilized daily. The corn starch is converted to alcohol and the valuable by-products of protein and oil are used for animal and human food.

This is an industry that has made tremendous technical progress in just five years. The energy consumption to make alcohol is about 25% of what it was.

Technically ethanol is an excellent fuel because it is an octane booster. It is one of the best octane boosters in the gasoline trade and is being used directly in the gasoline refinery to obtain the desired octane and to increase yields from the crude oil. Ethanol eliminates the need for lead in gasoline. This can contribute to the health of the nation.

Although much has been accomplished more needs to be done especially in the biological area. New needs are:

Improved yeasts

Yeasts that would give higher alcohol yields at higher temperatures would lower operating costs. More work in genetic engineering or protoplast fusion should be done.

Conversions of CO^2 to another chemical

In the production of ethanol, one-half of the weight of the sugar is converted to alcohol and one-half to CO^2. The CO^2 portion is either lost to the atmosphere or recovered and used as a coolant (a low value item). A major breakthrough would be accomplished if an economical route could be found to covert the CO^2 to more ethanol or to another high value chemical. This could lower the alcohol cost dramatically and have a tremendous impact on the industry.

Continued research on the use of plant byproducts and cellulose

Ethanol could be made from plant waste, cellulose from trees, etc. Much has been done but nothing is commercially feasible yet. This work should continue.

HYDROPONICS

ADM again has pioneered this industry in the Midwest with respect to utilization of waste heat from a processing plant to warm the growing crops in cold weather. About 40% of the total production cost in the winter is heat.

Historically, growing vegetables in the Midwest has not been economically feasible. However, rising costs of transportation from traditional growers in the Far West and Southwest has made Midwest vegetable production a concept worth serious consideration. At ADM the creative utilization of existing energy sources and by-products to maximize energy efficiency brought about the idea of a hydroponic greenhouse operation.

ADM hydroponics comprises 2.5 acres under roof with an additional two acres under development. Vegetables are grown in water with twenty-four nutrients added to stimulate and promote plant growth.

In the ADM operation, waste heat from the corn refining operation in the adjacent plant complex provides enough energy to reduce utility costs by 90%. Water at 160 degrees F is piped to the hydroponic greenhouse in a closed loop. On returning, the water will have cooled to 120 degrees F. The water heats the greenhouses and warms the nutrient solutions as well. Carbon dioxide, drawn off during the fermentation stage in the production of fuel alcohol, is piped to the hydroponics operation to help increase and stimulate plant growth. A greenhouse of cucumbers can use all the normally available CO^2 in the house in 15 minutes. By raising the level of carbon dioxide from 340 parts per million to 1,200, plant yields can be increased

from 20% to 40%. The use of waste heat and carbon dioxide are factors that could make hydroponics a cost efficient operation.

Hydroponics is still an experimental operation. If commercially successful it can open a large new industry in the Midwest because there are many processing and utility plants with waste hot water.

However much research is needed.

Improved seeds

Better seeds need to be developed specifically for hydroponics. This could involve higher yields in a shorter time.

Engineering research

The planting, growing and harvesting steps needs to be further mechanized otherwise hand labor can be prohibitive.

Gentlemen this concludes my comments.

Again I want to thank you for this opportunity.

I would be happy to try to answer any questions.

Mr. DURBIN. Thank you, Dr. Long.

Our next witness is Mr. Pfieffer who is with the Global Foods of Mount Zion, Ill. Thank you for coming over here and we appreciate your testimony this morning.

Mr. PFIEFFER. Thank you for asking me to be here. I guess I would have to say I am honored to be here with two giants in the industry.

We are using their products. I have prepared, oh, I'd say something very briefly. I apologize. I see everybody has prepared comments. I had prepared something just in notes and in listening to the comments this morning, I have changed it. So I guess if I had prepared something ahead of time, it wouldn't have been any good, anyway. I have been out of town, attempting to sell the products that these gentlemen are trying to design and improve.

Let me just give you just a real brief synopsis of what Global Food Industries is. We are a marketing agent and we are selling products that are the soy protein products and the wheybased products. My training has been in engineering. I was involved, got involved last year in a company that does research and design of various products, along with the help of ADM and Staley's.

That company is Royal American Food Co. We developed a concept in working with that these products should be able to be used in the private sector in the institutional food sales. So we launched in January a marketing effort across the United States to attempt—I shouldn't say attempt—to put the products in the hands of the end user.

I was thinking this morning, as I listened to all the comments, what I could add to this. I guess, really, where I have been is out in the field, talking to the people that are going to use this product, and I've seen some problems. I think as far as the research and design in this area and I will confine, of course, my comments to the soy protein area, the technology is really here. Apparently, you'll be treated that something that's new and I wasn't aware of that, that you'll be able to taste some of the food to see what the state of the art is.

We have found in working across the United States that the comments I heard this morning are correct, that the lower income people are the ones that will benefit from this research. The so-called middle-income or upper-income people use the products but they use them very lightly. We have found that institutions will

and can use them. I don't know how many of you have actually eaten any, other than just maybe once or twice, of these soy protein meals. If you backpack, you probably have. Or if you've seen some of these companies that are now starting up to market these, you may have tried them.

What we have found is when we prepare meals across the United States to introduce people to these, we try not to tell them what they are eating. In all cases, unless there was somebody there that was an expert or who had worked in soy protein, we found they could not tell the difference between that and actual meat. I think that's where I feel like I can add something to this hearing, in that the need is out there. It is actually just an education process, an acceptance process that we need to overcome in that area.

How do we do that? Well, I guess the letter that I got from you gentlemen listed several questions. I think the university, I know is working in this field. I am sorry to say, I don't know everything that they are doing. I have not really had the time to find out where their thrust is. But, again, it's the education process, getting people aware of what these products are, how good they are and how good they are for you. And, in fact, helping to convince the general population that there is a large—well, that there is a good food source here that is really much better for you than the conventional protein.

Mr. Skeen mentioned cattle.

Mr. SKEEN. Just as a hobby.

Mr. PFIEFFER. A hobby, OK, so you wouldn't mind getting out of that hobby, right?

Mr. SKEEN. I will discuss that with you later.

Mr. PFIEFFER. It's my understanding that on 1 acre of ground, you can raise 60 pounds of protein with beef. The soy protein or the soy bean, as you're familiar with, that you will get 2,000 pounds of protein. I think as you look at the world and the U.S. hunger program, it is obvious to me that the savior in this is going to be the soybean and, again, the gentlemen here have developed this to the state of the art as it is today.

I really don't know what else I can add. I am with a small firm. We don't expect to do over $3 or $4 million in the first, say, 12 months of operation but, again, I think that—and Dr. Hahn referred to it in his report—the second revolution in the art, I guess you would call it. The potential is just tremendous, just absolutely tremendous.

One question you had asked in your letter was what can the State and Federal Governments do. I know there are many people working on this. They are attempting to change some of the laws and rules. You've got the school lunch programs estimated at 12 to 14 million meals per day. Really, just that alone, could be a tremendous boost to the postharvest, as you call it, if we didn't have all the requirements of the 70-percent animal protein, 30-percent vegetable. Believe me, you can't tell the difference between these products. In fact, I've had comments all over the United States, and I'm talking about New York, Los Angeles, San Francisco, Detroit, from all of these, people asking us after we prepare a meal, how we made it, what it's made from, where can they buy it,

what's the recipe and I show them it came out of a bag, and they just can't believe it.

So I think acceptance is the problem. The State and Federal Government can help in that. Universities can certainly help in that and I am sure that they are now.

That's all I have to say and I would answer any questions.

Mr. DURBIN. We will have some questions for you.

Let me step out of order for a second here and recognize a couple of people in the audience who have been kind enough to attend.

State Representative John Dunn from Decatur is here. John has been representing this area in the Illinois House for about 8 years now, John?

Mr. SKEEN. He represented you well last night.

Mr. DURBIN. I am sure he did.

Also mention has been made of hydroponics, and although that's maybe slightly off the course of where we're headed today, I think it's relevant. In bringing that subject up, I'd hate to fail to mention another gentleman in the audience, Dale Hedgecomb of Hedgecomb Enterprises, a local businessman who is also working in some of these areas, too, trying to develop the technologies that will be part of our new food diet in the future.

I have to tell you, Dr. Hahn, there is not a congressional hearing that takes place in the United States of America that goes on for more than 10 or 15 minutes where the word "Japan" is not mentioned, and this one is no exception.

You said something earlier which I think caught everybody's ear on the panel, we all perked up, when you suggested that the failure of the United States—I am paraphrasing what you said—the failure of the United States to invest early in fructose has caused us many losses to Japan and other markets.

That's right up our alley today. Give me an idea of how this happened and what we should have done to avoid it.

Dr. HAHN. OK, the initial discovery of the Isomerase enzyme was made in the United States in about 1955. The United States did not pick up on this development, the Japanese did. They spent the 10 or 15 years in fermentation research and was really the basis of a lot of their fermentation expertise now that we're battling against.

But they took the discovery, did the basic research and then licensed the enzyme and the process to the United States and we paid well for that for a number of years until we could develop alternate sources in Europe. Unfortunately, there was not a U.S. enzyme fermentation industry at that point. We had not invested, we had allowed that particular technology to almost drop out of existence.

Mr. DURBIN. What amount, generally, is spent by Staley each year on research?

Dr. HAHN. In excess of $10 million.

Mr. DURBIN. Do you feel there is any given area or product right now where, again, we are turning our back or something, where 10 or 20 years down the line, we'll be buying from Japan or some other country, we could be developing ourselves?

Dr. HAHN. Really, the question is trying to identify what basic technologies are going to be important to us 10, 15 years out in the

future. That's a very difficult task and if I could do that, Staley would be investing in it and we'd make a mint.

But I think the message that I would like to give and I think Mary Carter will probably agree, you have to invest, you have to take technologies and invest in it for the long ride, not be faddish about the research you support. Right now, genetic engineering is a faddish technology and there is a lot of interest in it. But what about some of the separation technologies and some of the other things, food science and nutrition and all, that are not now particularly faddish and are not getting the support on the basic side?

Mr. DURBIN. How do we zero in on those? How do we pick the ones that are promising, the so-called sunrise technologies that, really, we don't want to spend our money, there is so little in Washington. We don't want to spend it on things that don't have promise or hope.

There were some suggestions earlier about the joint venture, bringing in the private side and the public to work together.

Dr. HAHN. I will comment on that in a second. But one thing to remember, for every research technology you invest in, there are probably 95 failures for every 100 you try. You've got to have a broad-based approach and lots of them, in order to have the one that is going to be viable.

Now, what can we do? I think we can do a lot better job of participation between industry and the private sector and the public sector in evaluation of research programs in cooperation at the very basic level in these initial discussions.

Now, there are several things that are going on. I participate on some industry panels that work with the ARS, and so forth, trying to input into their long-range research programs.

Staley is discussing proposing with one or more universities of establishing a professorship in a basic technology such as carbohydrate technology and I think there are things like that that industry can do to try to get their point across to the people, the Government agencies, and people doing the funding of basic research.

Mr. DURBIN. Dr. Long, where does ADM turn when you're looking for the basic research to develop product lines and looking to that 10 or 15 years down the line? What has been your company's approach?

Dr. LONG. Well, our general approach is cooperation with many of the other research units around the world and I'd like to say that I think that work with research units around the world is going to become the coming thing.

There is still not a U.S. enzyme industry, to speak of. The main suppliers of enzymes for our industry, the fructose, are still Denmark, European countries, something of this nature. They are building plants in the United States but I really think it's going to be a worldwide thing and I think that insures that new technology is developed and commercialized quicker. And we make a very, very determined effort that we keep abreast of all the technology around the world and very openness with these suppliers, these new research groups, and all, so that if something does come up which we spot or which we are interested in, we can commercialize in the minimum amount of time.

I think more and more of that is going to be done because research is very expensive. If you work very closely with your enzyme suppliers, you have 500 people around the world working on your project, which, in the long term, I think, pays off very well.

Mr. DURBIN. Mr. Pfieffer, no apology is necessary for not bringing prepared remarks with you. I appreciated your comments off the cuff and I'm sure you're going to get some questions from the panel here.

As you said, we are going to have at noon today, a little luncheon that focuses in on corn and soy products and attempts to educate the people, the few who will be able to attend it—I'm sorry everyone can't—to what we actually can produce for the table and how it is not only nutritious but also very appetizing. There are quite a few items in here that came to my surprise, as I looked through here, what can be made with corn sweeteners and soybean-based products.

If I'm not mistaken, there was an article written of one of your companies this last winter in a Chicago newspaper. If I'm not mistaken, you had sent some products up to be served in the Chicago area to what is euphemistically called a soup kitchen, people unemployed, needing help. And the people that came out of that kitchen after your meal of whatever it was, lasagna or whatever you served that day, gave you rave reviews, said it was the best meal they had ever had at that particular meeting place and they were anxious to try it again.

I think you said that earlier, that just given a chance and given the opportunity to expose your products to the consumer, you can get acceptance.

I guess my concern, though, is looking forward in the industry to the use of soy-based products, are we talking about a future potential that's really geared toward lower income or trying to break that barrier into middle-income families?

Mr. PFIEFFER. I really don't know if I can answer that. From what we have seen right now, the acceptance will be in the lower income because of the fact there are so many people out of work.

I spent 2 weeks in California, in the Los Angeles area and I just got back last weekend. We keep reading about the recovery but when you get down with some of these people that don't have any food and no jobs and some of them don't speak English, you find out that as far as they are concerned, there is no recovery.

I think right now today, the acceptance will be in the low income. To move it into the middle-income and upper-income people, that will, I think, happen through the university. I think that will be the quickest source to educate people.

As far as taste, the meals are excellent, palatable, good for you, but I think people just have a—unless they are, say, into the health-related fields, where they are very conscious about health, they would look at these products. Otherwise, they look at soy protein and they think, oh, that's that hamburger helper that came out several years ago, and they didn't like. My understanding is some of the instructions weren't the best and people didn't use it properly.

The products today, you could fool anyone. I could prepare a soup which maybe you will get from Staley Co., that we've had

people, after they taste it say, "All right, we understand that most of your products are soy protein but this one is meat." And they actually—nobody has got up and said, "I want to fight," yet, but they almost threaten to do that, because they just can't tell the difference. It tastes good, looks good, the shelf life on it, the ones that we sell in a sample pack, four servings in a package, it has a 2-year shelf life—plus, really if it's in dry condition. You take it out in Arizona, New Mexico and keep it dry, I don't know how long it would last, 10 years, or more, I suspect.

But again, back to your question, it's going to take an education process. It was mentioned by one of these gentlemen that it takes 20 years to pay back on the research. It's been about that long for soy protein, has it not?

I know one of the fellows who worked initially in this TVP for ADM, it's been going for a long, long time and now, just now, really in the last couple of years, I believe, you've got the products, the concentrates are what we work with, that if for lack of anything else, you can fool people with. As long as they don't know what it is, they will eat it.

So I guess I don't know how to answer, other than that.

Dr. HAHN. Let me expand on that just briefly.

There is a segment of the population that is going to be very attracted to soy, the nutriton diet conscious people and I think the thing that we need to do is get the message out that soy is good nutrition, it's very high quality protein, that products such as you're going to eat today can be prepared from soy, that I think will attract people of higher income levels, people who make the choice for reasons other than—they are choosing it for good nutriton.

Mr. DURBIN. Joe Skeen.

Mr. SKEEN. Thank you very much, Mr. Chairman. I feel somewhat under attack but I want to assure that I am not. I'm a hard guy to attack.

But this has been most interesting, because I think it really hits at the heart of the whole process, right from the research and development aspects, clear on through the marketing, and I appreciate this panel, particularly, you're private sector, you're talking about a $10 million investment from one local company and I don't know what ADM is doing in R&D, but I would say probably, compared to your earnings, you have a very high percentage of research and development commitment of funds.

And, Mr. Pfieffer, I like your attitude, too. You're out there doing the thing that we don't do well in the United States sometimes, we take for granted, and that is you're the actual marketer. You're trying to convince those folks and establish a market for a very good product.

I am a traditionalist, yes. I am in the cow business because I inherited some of that business and we're probably going to raise these cattle for a long time. We're also in the sheep business, and for many years we didn't think that there could be anything that would ever take the place of a good wool suit and so on. And we find ourselves with the kind of technological advance that we have in the United States, that all things come to pass if we work hard enough at it. We've done a pretty good job, except for one aspect,

and I think Dr. Hahn touched on it: How do we avoid things that—we develop a technology but we become purists in the antitrust section and some of the technological transfer, and we've built more barriers through Government and the laws that have made us give away some of our technological advantage because we want to be pure at heart and we don't want to have antitrust—we don't want to deal in monopolies and things of that kind.

How do we avoid that? How do we encourage joint ventures? We're going through that process in hearing now and I'd appreciate any suggestions from any of you gentlemen. For instance, just in the group sitting here today, I know that ADM does a tremendous amount of advertising but their trademark isn't on one product that I know of.

Dr. LONG. That's correct. We don't have consumer products, except the macaroni-type operation——

Mr. SKEEN. That carries your brand name.

Dr. LONG. Right.

Mr. SKEEN. But you still believe in a great commitment to just advertising which is part of your operation.

Dr. LONG. We have TV commercials.

Mr. SKEEN. They were mentioned to me by my colleagues over here.

Dr. LONG. You know, it helps profits.

Mr. SKEEN. Well, it certainly does but, still, you have an altruistic effort in that regard.

I want industry to emphasize that thing, because we've been too meek about saying, these are some of the good intents that we have. Sure, we want to make a profit. That's what makes our whole system work.

Dr. LONG. Well, I think one example is this hydroponics. This is—you know, may never make any money, but no matter you go on a business call, that is almost the first thing that these people want to talk about, about something like the hydroponics and how is it coming. Everybody that comes to Decatur wants to go visit. There is tremendous interest in these new things and many of them will succeed but, of course, as Dick said, 95 percent of them will not.

Mr. SKEEN. Well, let me encourage you, Dr. Long, that in the hydroponics area, alone, just in fertilization and application of water and water requirements on plants alone, you're changing our view in the southwest because everything we raise there is by irrigation. We are taking cues from the Israelis and the rest. We're becoming a vineyard producer. Of course, the first thing on the news this morning was, "Wine growers are in big trouble, they are overproducing." And we're going to do something about that?

Just one question and I will get off because I don't want to take up your time, in this statement, I think Mr. Pfieffer mentioned it, that we have looked for this universal protein, high-quality protein, for many years in the United States. That's been one of our goals, because we think that with just the productivity in the United States alone, we could adequately feed the entire world and I don't think we would miss it too far. And I think we're going in that direction with this kind of protein production.

Just how much is your effort, along with, say, a company like Dr. Long's and one that Dr. Hahn represents, too. How much coordination is there in that aspect of providing—is this a conscious thing with you and a deliberate effort on the part of all three of you, in getting together to provide, say, Third World countries with a very *cheap, high-quality protein?*

Mr. PFIEFFER. We've only made really one attempt. As I said, well, we really started with a concept last year in May and then full time in January. We may have approached the wrong people but we did do a mailing to all the industries to see if there was somewhere to go to find an interest in export.

What we really found was we really didn't find an interest. Most of the comments we got back were, well, if you read between the lines, it was that they would prefer to export to the United States rather than import from the United States.

Mr. SKEEN. We understand that.

Mr. PFIEFFER. I am sure you do.

Dr. LONG. We make a determined effort to sell these soy products into all aspects of overseas operation. We have a big effort in the Third World—type countries, but the main thing you also must have is the technical staff to help these people utilize the product when you get there. So we have various prople who travel the world, trying to sell and maybe has a technical group that goes with him, to show the organizations how to use them.

Dr. HAHN. The first question that these people ask you when they come over here and you want to sell them soy protein, they say, "Well, show me the American people that are eating it." And they don't want inferior products to be shoved on them, so one of the thrusts that we have made as a company is to try to get the scientific data that says soy protein is equivalent to meat, milk, and eggs as far as nutritional quality. And we've funded human studies at MIT and places like this, to demonstrate that soy protein is a high-quality protein, formulated foods that will appeal to the U.S. consumer, and then I think there is an opportunity worldwide to do this kind of thing.

Mr. SKEEN. That's a very interesting thing because we had a hearing the other day, Science and Technology, on nutritional research and we have a similar problem that parallels the one that you have in postharvest technology in that there is no real coordination, either, from the private and public sectors on that. Thank you very much, Mr. Chairman.

Mr. DURBIN. Paul Simon.

Mr. SIMON. Yes; I am curious, Mr. Pfieffer. You said you made a mailing to the embassies. Are you talking about the foreign embassies in the United States or U.S. Embassies abroad?

Mr. PFIEFFER. No; the foreign embassies in the United States.

Mr. SIMON. I might just pass along a suggestion. We are, in theory, beefing up U.S. Embassies abroad, with our commercial attachés. They are now supposed to be people who are not theoreticians, supposed to understand how to sell U.S. products, and so forth.

You might want to write to U.S. Embassies in all these countries, to their commercial attaché. And that person is now under the U.S. Department of Commerce, not under the State Department, and I

am curious as to what kind of answer you're going to get when you write. So if you can follow through, let us know.

Mr. PFIEFFER. I will do that.

Mr. SIMON. Second, I would like to underscore, first, one of the points that Dr. Hahn has made,

> Public funding for basic research in our universities must not be allowed to diminish. We must not overwork a fundamental component of a successful research formula, the quality, training of scientists and technical personnel.

It's easy to overlook this. Last year, Japan was just another field, but Japan graduated twice as many electrical engineers as we did. Japan has half our population. You don't need to be a prophet to guess who's going to be ahead in electronics 10 years from now, so we have to pay attention to that area.

Then I would like to follow up the chairman's question on Japan. When I visit with Japanese industrial leaders and I say, "How can we learn from you now? You've been learning from us very effectively."

One of the things they come back at over and over, and I hear this, I think without exception, is, they say, "You are much too much short-range oriented, not enough long range."

Now, to a certain extent, the three of you are a little bit like those of us in politics. Instead of an election, you're looking for a stockholders' meeting or you want to make a good report in that next annual report that you get out.

How do we, in Government, encourage the Staleys, the ADM's, the Global Market people, to look more long range? It's a very general question but I think it's an important one.

Dr. HAHN. Let me jump on it first. The Japanese do two other things besides looking long range. First of all, they share technology very broadly among their industries. The corn industry over there, basically, has no secrets among one another, but they also divide up the market share so that everyone profits. Well, I certainly don't think that we ought to go that direction. But, yes, I think you have to, someplace or another, make it possible for companies like Staley, ADM, and so forth, to have a long-range vision that says what's out 5 and 10 years, and says, "Yes, we can invest this money in new technology and have reasonable hope of success."

The other thing, as a country, we have to have a basic commitment to our development of the basic sciences at the universities, that this is going to happen.

I have one concern that's come out of this genetic engineering thrust, and now every professor in a university is now an entrepreneur.

But somehow, we have to get back to the concept where the university professor is doing basic science, he's working for knowledge sake and not looking over his shoulder to make a buck. And in industry, we will select from those technologies and exploit them to develop the new products.

Dr. LONG. One thing, maybe more of a tax incentive on research which might help the industry do more of this.

You spoke a minute ago, in Japan, twice as many engineers graduated there this year than graduated here, of the chemical en-

gineers that graduated this year in the United States, maybe 30 or 40 percent of them jobs and so I understand that over at Iowa State, which I am most acquainted with, this year, the freshman engineering enrollment is down 30 percent already. So, although we ride up and down the roller coaster, I think, really, the laws and all should be such that really encourage worldwide cooperation in exchange of research because the more people you have thinking about a problem, the sooner the solution will come.

Mr. SIMON. If I may interrupt a minute. Yesterday, the New York Times had an article by the president of Control Data, in which he says almost the opposite of what you're saying, and that we are too open with our research information, that Japan and other countries are coming in here and getting our information but we're not getting it from other countries.

Dr. LONG. By "openness," I mean publications, patents, this type of thing, that's public knowledge for anyone. If you're going in, stealing something, that's something else. But I mean, just openness, cooperation among the companies—I see nothing wrong with that.

Mr. SIMON. He doesn't suggest anything about anybody stealing anything. But he says that people from Japan and other countries work in our universities, work with our corporations, take the knowledge to other countries but it tends to be a one-way exchange. It's not coming back here like it ought to.

Dr. LONG. I don't necessarily think that's the case, at least in our case. You sometimes have to get out and work for it but it's there.

Mr. SIMON. Mr. Pfieffer, any comment you might have on this long-range thing? You're still struggling with the short range.

Mr. PFIEFFER. I think we are, that's true. We look at ADM and Staley for the long-range new technologies and growth. Really, I think ours right now is just looking at increasing sales and increasing awareness and that's going to help in, I think, all areas.

Mr. SIMON. And on a really short-range thing, you think I'll survive lunch hour here today?

Mr. PFIEFFER. I hope so.

Mr. DURBIN. Lane Evans.

Mr. EVANS. Well, picking up on what Paul just alluded to, what is the role of small business in this whole new technology? Do you see that as a growing involvement of small businesses in our State and other agricultural States?

Mr. PFIEFFER. Well, when you say small business, referring maybe to small packagers and small marketing concerns, I think for the segment of this industry that we're in, small business is the only one that will get it out. The large food manufacturers have worked with these before but it's such a small part of their volume, they don't make their money on that, they don't make their profit percentage on that. They just really didn't do very well and they kind of dropped it.

Whereas, for us, that's it and that's what we have to make work. Ultimately, I think the end users will be out there, the institutional and the private users and the demand will grow and the large companies will be back into it on that basis. I think that role right now is called spearheading the new products and getting them out.

Mr. EVANS. I will shift attention off Japan and go back to Russia. We still have problems with loss of grain sales to Russia. One of my colleagues on the Agriculture Committee suggested that one of the ways we could recapture lost markets in our grain sales to that country is by processing the grains here, and processing part of the grain into cattle field because the Russians are tending to get much more into the cattle business. I guess my question is: Has Staley or ADM looked into that aspect of the growing market in Russia?

Dr. LONG. Yes. Russia is one of the major importers of soy protein isolates, one of the major users in the world and, of course, they buy from the U.S. companies.

Dr. HAHN. We've also got the people who are exporting the processed product also got hurt by the embargo. We lost our market and we have not been able to regain it.

Mr. DURBIN. We hope to turn that around very soon. There's some positive development in terms of the long term.

Gentlemen, thank you very much. We appreciate your testimony.

Our third panel will bring us the university perspective and I invite up Dr. John Campbell, dean of agriculture, University of Illinois at Urbana; Dr. Bernard Liska, dean of agriculture at Purdue University, Lafayette, Ind.; Dr. Kristine Coryell, director, community relations, Richland Community College, Decatur, Ill.; and Dr. Joseph Avery, associate professor of agriculture, Richland Community College, Decatur, Ill.

While they are taking their positions at the table, I might add, since we've discussed Japan this morning, before we get started here with the university perspective, it was my pleasure to visit the Japanese Embassy in Washington several months ago. They hosted the freshman class and we went in to meet the various people and they couldn't have been more gracious.

I met their science adviser and when he asked me where I was from and I said, "Springfield, Ill.," and he said, "Oh, Illinois, I'm a graduate of the University of Illinois at Champaign and Urbana." So the science adviser at the Japanese Embassy is a former Illini and still follows it very closely.

Maybe that's a good start, Dr. Campbell, for your testimony this morning and I encourage the panel, as well, to condense their remarks and we'll submit the entire written testimony for the record.

Dr. Campbell.

STATEMENTS OF DR. JOHN CAMPBELL, DEAN OF AGRICULTURE, UNIVERSITY OF ILLINOIS, URBANA, ILL.; DR. BERNARD LISKA, DEAN OF AGRICULTURE, PURDUE UNIVERSITY, LAFAYETTE, IND.; DR. KRISTINE CORYELL, DIRECTOR, COMMUNITY RELATIONS, RICHLAND COMMUNITY COLLEGE, DECATUR, ILL.; AND DR. JOSEPH H. AVERY, ASSOCIATE PROFESSOR OF AGRICULTURE, RICHLAND COMMUNITY COLLEGE, DECATUR, ILL.

Dr. CAMPBELL. Thank you, Chairman Durbin, members of the committee, I am pleased to be here today. I'm not a graduate of the University of Illinois, but I'd be proud to be.

I am dean of the college of agriculture at the University of Illinois and today, we focus our attention on postharvest technology.

This very important part of America's successful food system serves as a link between what the farmer produces and what the consumer eats. As pointed out by Dr. Phillips, this is big business and employs about 23 percent of the country's work force and we are very proud of the production chain that we have in the United States.

It was pointed out, again by Dr. Phillips, that nearly $300 billion was generated by this business and $81 billion represents value added which, of course, we're very, very interested in.

Nevertheless, the food industry faces some tough challenges. Many of these problems impact the public. Consider just one example: According to a GAO report, 20 percent of the food produced in this country is wasted. This amounts to a huge economic loss. And to make matters worse, with each passing year, research, and development in postharvest technology lags further and further behind the industry's needs. We need additional basic research to provide the technology that will help us to increase labor productivity, improve processing and preservation of foods and thereby reduce that loss we spoke of, to improve the efficiency of marketing distribution which, hopefully, will lower food process in terms of real terms.

To what extent should the Federal Government invest in postharvest technology, research and development? Permit me to address four points:

First, how does postharvest technology impact on the economy in general; second, what role should land grant colleges of agriculture play in the development of postharvest technology; third, what part can university-industrial interaction play in this process; and, finally, how can the United States meet the continuing demand for food-industry personnel with the special skills needed to generate and implement these developments?

First, the economic impact and this has been covered in large part by Dr. Phillips, the postharvest component of our food system affects the United States in enormous ways—numerous ways. First, this area helps provide Americans with inexpensive food supply. The fact that our consumers spend only 16 percent of their disposable income on food, which is less than anywhere else in the world, results not merely from efficient farm production but also involves the whole area of postharvest technology. The real price of food decreased substantially from the mid-1930's to the 1970's. But during the past decade, it's leveled out. This, I believe, results in part from a decreased commitment to research and postharvest technology.

More than approximately 30 cents of the food dollar goes to the farm that produces it. The other 70 cents goes in the area of postharvest technology. We also know that about 70 percent of the budgets of USDA and SAES go to production-related research. I think this is important and it's been a very important part of our maintaining the productivity of this country. It's also very important to making us competitive in the world market.

So on the other side, the 70 cents that goes into postharvest technology has not received the support base and we're spending only about 18 percent of our research budget in this area. I think this has put us in a position of not being as competitive and not being able to make strides that need to be made.

Second, postharvest processing and distribution comprises a very significant sector of the Nation's economy as noted by the fact that we are spending $300 billion on food, food processing, and so forth, in this country. It also creates millions of jobs.

I want to speak now to the role of land grant colleges and universities. If postharvest technology could keep pace with the Nation's needs, additional investments must be made in research and development in this area. I want to add that I don't want just to see us do a reallocation but we need new moneys in this area.

The land-grant college's natural role should be in the research part of R&D. The universities provide manpower. They help manage the economy and certainly provide much of the new knowledge that fuels the economy. Technological areas typically encompass a continuum of scientific disciplines, the basic sciences on one end, the applied on the other. The creation of new knowledge of nature on one end, the development of processes and products on the other.

As now organized, agricultural experiment stations are better able to emphasize basic research while product development is better conducted by industrial establishments.

Traditionally, agricultural production research has been supported in the main by public moneys. This has been because each of the thousands of farming operations is too small to mount a significant research and development effort.

Similarly, the major beneficiaries of postharvest technological progress—this Nation's consumers—cannot, as individuals conduct research and development, either.

Several areas stand out as fitting examples of the basic research and the continuum mentioned earlier. These include genetic and physiological aspects of the chemistry of agricultural products, procedures to insure the safety of food to the human population, human nutrition, nutrient losses during food processing and storage, reducing the energy requirements of food processing and processes for modifying the physical, chemical, and functional properties of food materials. And these are but a few of the many.

The State of Illinois has recognized the importance of agricultural research for many years. Recently, through its food for century III program, Illinois demonstrated this commitment concretely. In regard to postharvest technology in particular, as a result of food for century III funding, which is entirely State money, an agricultural engineering sciences facility is near completion and it will house state-of-the-art, pilot-plant capabilities dedicated to research and teaching.

Various segments of the postharvest industries have shown their interest in interacting with the University of Illinois faculty by way of providing financial support for ongoing research activities, initiating collaborative research programs and donating or leasing at nominal cost major research equipment and instrumentation.

Example areas of research that are going to focus in these areas, include genetic engineering, computer-assisted fermentation technology, nondestructive compositional analysis of biological tissues, and membrane technology in biological conversion processes.

The third area, interaction between land-grant colleges and industrial firms: The land-grant agricultural colleges have served

this country's farmers and the consuming public well for more than a century. Agricultural experiment stations—working together with the food industries—have contributed to the abundance, wholesomeness, and safety of our food supply. The hallmark of this land-grant system all along has been objectivity.

But now, real public support of research in postharvest technology is on the wane. Not only has inflation taken its toll, but the complex, sophisticated investigative approaches required today are much more costly than were those of yesteryear.

Public moneys simply have not kept pace. In the last several years, constant-dollar expenditures for postharvest technology and marketing economics research by USDA and the State agricultural experiment stations have declined by 8 percent.

The direct result has been appalling. In the past, the United States has led the way in postharvest technology but that is no longer so. Consider three pieces of evidence: First, Japanese researchers recently made a major breakthrough in the development of high-fructose corn syrup, which has led to the dramatic changes in the food industry and has resulted in major savings to consumers.

Second, the Japanese have also made important biotechnological inroads in the production of aspartame, the new low-caloric sweetener that competes with saccharine.

The raw materials—amino acids—are manufactured in Japan, using Japanese technology. In fact, the U.S. developer of aspartame currently buys the raw materials from Japan because our own technology is not now capable of producing a sufficient amount at a cost-effective level.

Third, various European nations have taken the lead in developing many items of high-technology equipment for postharvest applications.

The heyday of American leadership in these areas is, at least for the present, past. Will we be content to watch others step out in front? The recent histories of fructose sweeteners, aspartame, and high-tech equipment development alone provide ample evidence of the need to strengthen our fundamental research program in this area.

Thus, under the present circumstances, it is not surprising that land-grant colleges and industrial firms have turned to each other to share expertise and costs, as much needed research is implemented. The colleges desperately need dollars, while the industry desperately needs a more dynamic knowledge base.

I should also point out that the universities and industries work through consulting arrangements which have also been important. Such consulting is not permitted with personnel of USDA.

I am eager to see our college expand research efforts in postharvest technology. To be realistic, we must be willing to explore special arrangements to gain access to private dollars with which we can underwrite these new initiatives. Of course, we must be certain that these new programs be consistent with our overall research mission, that they be of fundamental nature, so essential to the foundation of sound graduate education and training and that our tradition for objectivity remain pure and intact.

Despite the current surge of interest in university and industrial relationships, industry's interests might have real limits. Food processing firms are not big spenders when it comes to research and development. A recent survey in July of this year in food processing, indicates that 64 of our 100 large American food processing firms spend less than one-half of 1 percent of their food sales revenues on research and development, while another 26 percent spend only between one-half and 1 percent.

Finally, the area of meeting the demand for specialized food industry personnel: When current enrollment trends in land grant colleges of agriculture are compared with the projected demand for agricultural graduates, some alarming discrepancies surface. One area facing serious manpower shortages is food science and human nutrition, the very area that shoulders the bulk of the responsibility for postharvest technology. An article in the Chemical and Engineering News, March of this year, notes that, "82 percent of the projected needs for manufacturing and processing scientists and engineers would be met."

And a January 1983, RICOP report stresses that, American agricultural colleges educate most of the scientists, professionals, and managers with agricultural expertise, graduating in excess of 65 percent of the 59,000 new workers needed annually.

But the colleges of agriculture face a critical task in attracting students today and in the foreseeable future. I will list four reasons for this:

First, agriculture must compete with other disciplines such as medicine and engineering and the decreasing number of students who acquire adequate scientific preparation in secondary schools, and we're hearing more and more about this on the national scene now.

Second, the current demographic studies show the college-age group will decrease 20 to 25 percent during the next decade.

Third, many colleges face serious shortages of qualified faculty members in many disciplines. That is a problem industry is also going to face. Many scientists who began their careers after World War II will be retiring during the next 5 to 10 years and replacements simply will not be available. An example of this is our own department of agricultural engineering, which recently advertised for three faculty members, but received only six applications and all applicants were natives from abroad.

Fourth, colleges of agriculture face stiff competition for advanced degree graduates from industry and from developing countries. We are often outbid and, in many cases, industry monetary incentives to new bachelor's degree graduates move them away from advanced degree programs and directly into the work force.

These problems clearly point out two critical needs: Our academic programs, including those in postharvest technologies, need revitalizing. But, first, we must compete successfully for academically talented students. Agriculture simply must identify the highly qualified students and then using whatever means possible, compete for their recruitment.

We have launched a major scholarship program at the University of Illinois College of Agriculture to assist in these efforts.

The mindpower problem at the graduate level is real, too, and public support of this vital area must be increased. My testimony given in March 1981, attests to the continuing need and concern in this area.

In summary, several trends are coinciding the call for renewed commitment to excellence in postharvest technology research and development.

First, the critical link between farmer and consumer is a significant factor in the Nation's economy and we will need to count on it more and more in the future as a means of increasing foreign exchange earnings, as well as providing dependable employment for our citizenry.

Second, the land-grant agricultural colleges can continue to emphasize basic research which could lead to increased shelf life, enchance food safety, nutritional value, and so forth. This will also impact our economy as we look more and more toward more value-added products. Rather than ship raw soybeans, we need to ship more soy flour, protein concentrates, soybean isolates, textured products, and so forth, and thereby gain this value-added advantage.

Third, university/industrial interactions are generally intensifying at this time and this is especially timely in the case of postharvest technology because of America's currently declining prominence in this area.

Fourth, the food industry's future demands for specialized personnel are critical, and agricultural colleges might well be unable to meet them unless ambitious new thrusts in student recruitment and program revitalization are mounted soon.

The hybrid vigor that would result from rejuvenated interaction among governments, industrial firms and land grant colleges would soon position the United States once again where this Nation belongs: at the leading edge of research and development in all facets of postharvest technology.

The Congress of the United States is to be commended for its support of agriculture research, an investment that returns benefits magnified manyfold. But to assure that this country retains its prominent position as a world leader in the production, processing, and marketing of food, we must renew this waning commitment to basic research that underpins our Nation's food supply.

Furthermore, this is necessary simply to assure us of the continued abundance of safe, wholesome food at prices that do not fuel inflation. Greater emphasis must be given to public support of research in this area of postharvest technology.

I urge your favorable consideration of this means of strengthening our enviable position of agricultural leadership in the world.

Thank you.

[The prepared statement of Dr. Campbell follows:]

STATEMENT OF

JOHN R. CAMPBELL

DEAN OF COLLEGE OF AGRICULTURE

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Chairman Fuqua and members, I am John R. Campbell, dean of the College of Agriculture at the University of Illinois.

We focus our attention today on postharvest technology. This important part of America's successful food system takes what farmers produce and creates the thousands of products that line our supermarket shelves, meet the needs of a variety of industrial users, and even serve as replacements for fossil fuels.

This country's food industry depends on this critical link between the farm and the consumer. In 1981, 26,656 establishments, employing more than 1.7 million American workers, manufactured food and kindred products.[1/] The overall food and fiber system of the United States employed 23.7 million (23% of the total employment in the country) in 1980. In millions, this was distributed as follows: production agriculture (farm), 3.3; food processing, 1.7; resources and services, 2.5; manufacturing, 5.1; transportation, trade, and retailing, 7.7; and eating establishments, 3.4.[2/] Of the $272 billion worth of products shipped in 1981, $81 billion represented value added.

Nevertheless, the food industry faces tough challenges ahead. Many of these problems impact on the general public. Consider just one example: According to a General Accounting Office estimate,[3/] 20 percent of the food produced in this country is wasted. This amounts to a huge economic loss. And to make matters worse, with each passing year, research and development in postharvest technology lag further and further behind the industry's needs.

1/ Data Analysis by Randall W. Westgren, Professor of Food Marketing, University of Illinois College of Agriculture. Data from 1981 and 1961 Annual Survey of Manufacturing, 1977 Census of Manufacturing and 1958 Enterprise Statistics.

2/ Agricultural Postharvest Technology and Marketing Economics Research, A Technical Memorandum, Office of Technology Assessment, Congress of the United States, Washington, D.C., April, 1983.

3/ General Accounting Office Report, "Food Waste: An Opportunity to Improve Resource Use", September, 1977.

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To what extent should the federal government invest in postharvest technology research and development? Permit me to address four points related to this question:

First -- How does postharvest technology impact on the economy of our nation?

Second -- What role should land-grant agricultural colleges play in the development of postharvest technology?

Third -- What part can university-industrial interaction play in this process?

And fourth -- How can the United States best meet the continuing demand for food-industry personnel with the special skills needed to generate and implement these developments?

I. Economic Impact of Postharvest Technology

The postharvest component of our food system affects the United States economy in numerous ways. And there is every reason to expect that the importance of this segment of the economy will increase in the future.

First, modern postharvest technology helps provide Americans an inexpensive food supply. The fact that consumers spend only 16 percent of their disposable income on food in this country, which is less than anywhere else in the world, results not merely from efficient farm production. About 70 cents of every food dollar goes for postharvest processing, storage, marketing, and distribution of commodities. Thus, efficient postharvest technology is essential, too. Technological advances must be made in food manufacturing and processing, wholesaling, transportation, retailing, and food services, if we of the United States are to continue to enjoy relatively inexpensive food in the future.

Second, postharvest processing and distribution comprise a significant sector of the nation's total economy. With nearly $300 billion spent on food each year, the food-processing industry, alone, provides more than $81 billion of value added to the economy annually. This generates tax revenues, employment for more than 1.7 million, and ripple effects felt throughout supply industries, as well as local and state economies generally.

Third, in the future, not only will domestic consumers demand an even larger variety of food products, but as a nation, we will need to count on postharvest activities for greater foreign-exchange earnings. Exporting processed foods, rather than more lowly-valued farm commodities, supports the American worker and enhances our balance of trade.

II. Role of Land-Grant Colleges and Universities

If postharvest technology is to keep pace with the nation's needs, additional investments must be made in research and development in this area. And the land-grant colleges' natural role emphasizes the "R" portion of "R and D".

Technological areas typically encompass a continuum of scientific disciplines--the basic sciences at one end, the applied at the other; the creation of new knowledge of nature at one end, the development of new processes and products at the other. As now organized, agricultural experiment stations are better able to emphasize basic research, while product development is better conducted by industrial establishments. Yet both are involved and, inevitably, there is overlapping of objectives. Overlapping can, of course, be complementary.

Traditionally, agricultural production research has been supported in the main by public monies, because each of the thousands of farming operations is too small to mount a significant research and development

effort. Similarly, the major beneficiaries of postharvest-technological progress--this nation's consumers--cannot, as individuals, conduct the necessary research and development in this area.

Several areas stand out as fitting examples at the basic-research end of the continuum mentioned earlier,[4/] including: genetic and physiological aspects of the chemistry of agricultural products, procedures and policies to ensure the safety of foods to the human population, human nutrition, nutrient losses during food processing and storage, reducing the energy requirements of food processing, and processes for modifying the physical, chemical, and functional properties of food materials. These and many other areas of inquiry contribute to our general knowledge base, but not necessarily to the development of specific new products. Thus, it is appropriate that they be addressed by scientists at agricultural experiment stations. However, if these efforts are to be as efficient and effective as possible, they must be integrated closely with the industries' own research and development programs. This integration can take any of several forms, including the orderly sequencing of research objectives between universities and industrial establishments, outright scientific collaboration between university and industrial personnel, and the universities' education of students in ways such that they are specially skilled to be engaged in research and development with food-industrial firms.

Government can participate logically in this whole process by helping universities on several fronts. These include help in:

1. Establishing and maintaining a proper national philosophy on postharvest technology.

4/ General Accounting Office Report, "Food Waste: An Opportunity to Improve Resource Use," September, 1977.

2. Establishing national research priorities in this area.

3. Assuring that research remains free from undue political or private influence.

And 4. Coordinating joint university-governmental research programs, as well as in catalyzing university-industrial interactions.

The potential benefits from government's increasing its attention to this important area are tremendous. The current governmental commitment to the postharvest research enterprise in the United States is inadequate and undependable. Efforts to strengthen and expand this commitment at the federal and state levels are needed desperately, if this country is to retain world prominence in imaginative and innovative research on food and fiber.

The State of Illinois has recognized the importance of agricultural research for many years. Recently, through its Food for Century III program, Illinois has demonstrated its commitment concretely. In regard to postharvest technology in particular, as a result of Food for Century III funding, an Agricultural Engineering Sciences facility is near completion and it will house state-of-the-art pilot-plant capabilities dedicated to research and teaching. Various segments of the postharvest industries have shown their interest in interacting with University of Illinois faculty and staff by way of providing financial support for ongoing research activities, initiating collaborative research programs, and donating or leasing at nominal cost, major research equipment and instrumentation. Example research areas, which are already the focus of such interest and support are genetic engineering, computer-assisted fermentation technology, nondestructive compositional analysis of biological-tissues, and membrane technology in biological-conversion processes.

Governments, industrial firms, and universities have their respective capabilities and interests in postharvest technology. Without a doubt, the hybrid vigor that would result from rejuvenated interaction among the governments, the industrial firms, and the universities, soon would position the United States once again where this nation belongs -- at the leading edge of research and development in all facets of postharvest technology.

III. Interactions Between Land-Grant Colleges and Industrial Firms

The land-grant agricultural colleges have served this country's farmers and the consuming public well for more than a century. Agricultural experiment stations -- working together with the food industries -- have contributed to the abundance, wholesomeness, and safety of our nation's food supply. The hallmark of the land-grant system all along has been objectivity.

Alas, real public support of research in postharvest technology is on the wane. Not only has inflation taken its toll, but the complex, sophisticated investigative approaches required today are much more costly than were those of yesteryear. Public monies simply have not kept pace. Since 1978, constant-dollar expenditures for postharvest technology and marketing economics research by USDA and State Agricultural Experiment Stations have declined 8 percent.

The direct result has been apalling. In the past, the United States has led the way in postharvest technology, but no longer is this so. Consider three pieces of evidence. (1) Japanese researchers recently made a major breakthrough in the development of high-fructose corn syrup, which has led to dramatic changes in the food industry and has resulted in major savings to consumers. (2) The Japanese also have made important biotechnological inroads in the production of aspartame, the new low-caloric sweetener that

competes with saccharine. The raw materials -- amino acids -- are manufactured in Japan using Japanese technology. In fact, the United States developer of aspartame currently buys the raw materials from Japan, because our own technology is not now capable of producing a sufficient amount at a cost-effective level. (3) Various European nations have taken the lead in developing many items of high-technology equipment for postharvest applications.

The heyday of American leadership in these important areas is -- at least for the time being -- past. Will we be content to watch others step out in front? The recent histories of fructose sweeteners, aspartame, and high-tech equipment development alone, provide ample evidence of the need to strengthen our fundamental research program. Thus, under the present circumstances, it is not surprising that land-grant colleges and industrial firms have turned to each other to share expertise and costs, as much needed research is implemented; the colleges desperately need dollars, while the industry desperately needs a more dynamic knowledge base.

A 1982 report by the National Science Foundation[5/] points to 1978 as the year when discussions of university-industrial research couplings began to intensify. The report cites examples of research centers being founded, or redirected, to implement cooperative university-industrial efforts. These have taken a variety of forms, including limited partnerships and complexes of overlapping, non-profit, and for-profit organizations. But in any case, such an arrangement bears fruit in direct proportion to the increased understanding each party gains of the other's role in the joint process. The universities often gain access to new, much needed resources by means of such

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5/ North Central Association of Agricultural Experiment Station Directors, NCA-22, Priority Research Topics for 1983-88, January, 1983; Unpublished material attached to January 6, 1983 correspondence from Dr. A. J Siedler, head, Department of Food Science, University of Illinois College of Agriculture.

arrangements, but at the same time, they frequently give up some freedom of inquiry. At all times, objectivity -- the revered hallmark of the land-grant system -- must be preserved. We must express truth with a capital "T"!

I am eager that our college expand research efforts in postharvest technology, and to be realistic, we must be willing to explore special arrangements to gain access to private dollars with which we can underwrite these new initiatives. Of course, we must be certain that these new programs be consistent with our overall research mission, that they be of the fundamental nature so essential to the foundation of sound graduate education and training, and that our tradition for objectivity remain pure and intact.

Despite the current surge of interest in university-industrial relationships, industry's interests might have real limits. Food-processing firms are not "big spenders" when it comes to research and development. A survey reported in the July, 1983 issue of Food Processing[6/] indicates that 64 percent of the top 100 American food-processing firms spend less than 0.5 percent of their food-sales revenues on research and development, while another 26 percent spend only between 0.5 and 1.0 percent.

IV. Meeting the Demand for Specialized Food-Industry Personnel

When current enrollment trends in land-grant colleges of agriculture are compared with the projected demand for agricultural graduates, some alarming discrepancies surface. One area facing serious manpower shortages is food science and human nutrition -- the very area that shoulders the bulk of the responsibility for postharvest technology. An article in the March 23, 1983, issue of Chemical and Engineering News notes that ". . . only 82 percent

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6/ "University-Industrial Research Relationships," Fourteenth Annual Report of the National Science Board, October, 1982.

of the projected needs for 'manufacturing and processing scientists and engineers' would be met".[7/] The number needed totals 5,544. In the same article, Dr. T. B. Kinney, administrator of the USDA's Agricultural Research Service, points to the need for a reliable supply of agricultural professionals if this country expects to compete favorably in the world agricultural markets. A January, 1983 RICOP report[8/] stresses that American agricultural colleges educate most of the scientists, professionals, and managers with agricultural expertise, graduating in excess of 65 percent of the 59,000 new workers needed annually.

But the colleges of agriculture face a critical task in attracting students today and in the foreseeable future. This is because:

(1) Agriculture must compete with other disciplines for the decreasing numbers of students who acquire adequate scientific preparation in secondary schools.

(2) Current demographic studies show that the college-age group will decrease 20 to 25 percent during the next decade.

(3) Many colleges face serious shortages of qualified faculty members in certain disciplines -- a problem industry also faces. Many scientists who began their careers after World War II will be retiring during the next 5 to 10 years, and replacements often will not be available. Our department of agricultural engineering recently advertised openings for three faculty members, but received only six applications, and all applicants were natives from abroad.

7/ "U.S. Agriculture Faces Manpower Shortage," Chemical and Engineering News, March 21, 1983, p. 8.

8/ "Human Capital Shortages: A Threat to American Agriculture," A Report by the Resident Instruction Committee on Organization and Policy (RICOP), National Association of State Universities and Land-Grant Colleges, January, 1983.

(4) Colleges of agriculture face stiff competition for advanced-degree graduates from industry and from developing countries. We are often outbid and, in many cases, industry monetary incentives to new bachelor's degree graduates, move them away from advanced-degree programs and directly into the work force.

These problems clearly point out two critical needs. Our academic programs -- including those in postharvest technologies -- need revitalizing. But first, we must compete successfully for academically talented students. Agriculture simply must identify the highly qualified students and, through various means, compete favorably for their recruitment into our student ranks. Once this is accomplished, the opportunities are limitless -- so long as those students find challenging and demanding programs to capture their imaginations and focus their energies. We have launched a major scholarship program at the University of Illinois College of Agriculture to assist in these efforts.

The mindpower problem at the graduate-student level is real, too, and public support of this vital area must be increased. My previous testimony, given in March, 1981, attests to this continuing need and concern.9/

SUMMARY

Several trends are coinciding that call for a renewed and abiding commitment to excellence in postharvest technology research and development in the United States:

(1) The critical link between farm and consumer is a significant factor in the nation's economy, and we will need to count on it more and more in the future as a means of increasing foreign-exchange earnings, as well as in providing dependable employment for our citizenry.

9/ Testimony by John R. Campbell, Associate Dean of the College of Agriculture, University of Illinois, before the Subcommittee on Department Operations, Research, and Foreign Agriculture, Committee on Agriculture, House of Representatives, Washington, D.C., March 19, 1981.

(2) The land-grant agricultural colleges can continue to emphasize basic research in this area only if the government helps by providing monies and political support.

(3) University-industrial interactions are generally intensifying at this time, and this is especially timely in the case of postharvest technology, because of America's currently declining prominence in this area.

(4) The food industry's future demands for specialized personnel are critical, and agricultural colleges might well be unable to meet them unless ambitious new thrusts in student recruitment and program revitalization are mounted soon.

The hybrid vigor and additive effect that would result from rejuvenated interaction among governments, industrial firms, and land-grant colleges would soon position the United States, once again, where this nation belongs -- at the leading edge of research and development in all facets of postharvest technology.

The Congress of the United States is to be commended for its support of agricultural research -- an investment that returns benefits magnified manyfold. But to assure that this country retains its prominent position as a world leader in the production, processing, and marketing of food, we must renew our waning commitment to basic research that underpins this nation's food system. Furthermore, this is necessary simply to assure us of the continued abundance of safe, wholesome food at economical prices. Greater emphasis must be given to public support of research in the area of postharvest technology. I urge your favorable consideration of this means of strengthening our enviable position of agricultural leadership in the world.

Thank you.

Mr. DURBIN. Thank you, Dr. Campbell.

Now from Purdue—and I'm glad to see Purdue and Illinois share the same table here, opponents on the gridiron but you do well at a table of a panel of witnesses—Dr. Liska, who is dean of the school of agriculture at Purdue University.

Dr. LISKA. Thank you very much, Congressman. I appreciate the opportunity to participate in this hearing and join the Illini in the room.

My background includes research and teaching in food science for more years than I'd like to remember, currently dean of agriculture at Purdue University and recently I was selected as president-elect of the Institute of Food Technologists. This is the major international food science professional group with about 21,000 members. But I need to make the point that I speak for myself here and not for that group.

I'd like to commend the group that put together the postharvest technology report but then, as I recall, that Mike Phillips was involved in it, he's a Purdue graduate, so I expect that.

The study does identify some of the major challenges and approaches to take in the future, but it also points out one of the major problems is the lack of postharvest research dollars. The comments were revolving around comments from USDA but over the last few years, we've also seen a reduction in dollars in food science-related research and Food and Drug Administration, National Institutes of Health, and National Science Foundation, rather than just within the one agency. I think this is something to keep in mind because that's related to the basic research that we're talking about.

Many critics indicate this should be private industry responsibility. I hope we can finally reach an understanding that this should be a publicly funded basic research program in this area of high priority.

The States have viewed postharvest technology as an important public-funded research area and have backed it with increases in funding over the past 10 years. It is significant that local people support State appropriation in legislatures in the major food-producing States. They must realize the importance of postharvest technology to the movement of agricultural products and the benefits. Many checkoff programs in the States also fund State research in the postharvest technology area.

The postharvest technology area appears to have potential as an area of growth in the Midwestern food producing States. Fewer people will be involved directly in food production on farms but the overall agribusiness supporting system will provide more service to farmers. Also the value added involved in food processing translates into added jobs for America.

One example in my own State, a major part of the hogs go out of State to be slaughtered. The State is making serious moves to correct this by attracting slaughter facilities. This translates into new jobs. It also translates into the need for research information and educated food scientists. New industry seems to move to areas with good industrial environments, including availability of technical support.

With energy and transportation costs on the increase we should see development of some food-producing activities close to population centers. Again, we've, over the years, seen movement of some of the poultry industry from the Midwest to the South and now we're seeing a revival, at least in the egg production area, in our State. Really, why ship grain to the South and real fragile consumer product[illegible] to the Midwest and East?

If we ta[illegible]napolis, put a pin and go out 500 miles, we're within 500 [illegible] of some 45 percent of the people in the country, so I see this as some real opportunity in addition to this agriculture base that we have.

State governments, universities and the private sectors need to work together to provide an environment to attract selected industrial development. Value-added industries as food processing should be natural choices for the food-producing States in the Midwest. Maybe this is why there has been an increase in State support in this area.

In Indiana recently, State government, farm organizations, agribusiness and the university joined together to form the Indiana Institute for Ag Food and Nutrition, Inc. This is a nonprofit group to support and develop agriculture and agribusiness in the State.

The several groups involved can jointly address problems. A strategic plan will likely be one of the early projects. What is needed? What are the opportunities? What should State government do? What can or should the university do? There are opportunities which require this kind of teamwork.

Food processing will be one of the areas involved in the plan since the State is serious about the value-added opportunities. Our State and the Nation should be exploiting more value-added food products than raw grains and agricultural products.

The Purdue Board of Trustees has recently approved the formation of the department of food science at Purdue University. This will increase emphasis on this general area.

Several examples I've used are related directly to Indiana, since I realize I'm the only one here defending the Hoosier State, I thought that would be appropriate.

However, as I look at it from a Federal viewpoint, really, I think Federal policies and several agencies in recent years have reduced emphasis on this very important part of agriculture. Maybe this is related—you know, we go in cycles in research emphasis. Back in the thirties and so on, we had surpluses and we talked about utilization. Then in the last few years, we were more concerned about production and we kind of lost sight with where we were. Those kinds of cycles are difficult to absorb in the research and educational system. This really means that we lose a long term—in many ways we're critical of the private group because they are shortsighted and, really, the public sector is no more farsighted than the private. So I think this is something we need to address.

Maybe it would be logical to develop a list of priority research needs to keep the food industry from losing its competitive edge in the world, as well as providing domestic market for low-cost safe food supply. Maybe it is time for the appropriate Government, university and food industry representatives to come together to put forth an overall strategic plan of needs in postharvest research

that could lead to sensible Federal funding and supporting policies at both Federal and State levels.

Public-funded research programs should focus basically on fundamental research needs plus training. This research is to serve as a source of information for the private sector and used in the future development of our research efforts. The MS and Ph. D. trainees will also be the future manpower for the private sector development efforts.

Part of the reason we see some of the activities of faculty in consulting with industry, as was mentioned earlier by one of the individuals on the panel, we worry about that, too, that because of lack of public support, our good faculty has been making contact with the private areas, trying to generate research support for their programs here and this does considerably eat up time of people rather than to be able to really function along the research area with some of the funds that we should be adding to this area.

One area which needs consideration in future planning is how nutritional and eating habits of the American public will affect postharvest technology. As we find more scientifically sound information on nutritional needs and affect of diet on health of consumers, postharvest technology may take on additional importance. Genetic changes in plants and animals is a slow process. Food processing can be a faster way to make significant changes by the proper combination and processing of agricultural products into food ingredients.

There are significant opportunities for postharvest technology to contribute to the overall economy of the food-producing States.

Here, Mr. Skeen, if we could make sure we have a good supply of good, fresh lamb in this part of the world, I think it would help the industry.

Mr. SKEEN. We've been doing our very best for about 30 years.

Dr. LISKA. So there are a lot of opportunities is what I'm saying, to get agricultural products in the right form at the right time at the right place and at a reasonable cost.

The Federal Government should increase its support in this area of research. Dr. Campbell indicated this and when you support the area, the basic research program, the addition that you get is the additional training, and so on, because if we had additional support, we would see an influx, I think, of more young people doing graduate work here. You know, when you get to my age, you've contributed most of your good ideas from a research point of view. It's those young minds that don't understand that something is very difficult to do that will make some of the real impacts on the new ideas and technology to look ahead. So this really is an important part of it.

I think in order for this kind of development to happen, we probably need to really move ahead with an overall plan which involves the people from industry helping the university and Government to decide where are the important opportunities and challenges in this area, and for once, all of us get around the table and decide what's important and get behind it.

Thank you.

[The prepared statement of Dr. Liska follows:]

STATEMENT BY B. J. LISKA TO THE SUBCOMMITTEE
ON INVESTIGATIONS AND OVERSIGHT HEARING
TO CONSIDER POST HARVEST RESEARCH, TECHNOLOGY
AND ECONOMICS AT DECATUR, ILLINOIS ON JULY 25, 1983

I appreciate receiving the request from Congressmen Richard Durbin and Albert Gore to participate in this hearing. My background includes research and teaching in food science. Currently my position is Dean of Agriculture at Purdue University and recently I was selected president-elect of the Institute of Food Technologists. This is the major international food science professional group with about 21,000 members.

The group responsible for the April 1983 study PHTME should be congratulated. The study identifies some of the challenges and approaches to take into the future. It also points out that one of the major difficulties in PHTME research has been a reduction in funding from federal sources. This is true from USDA, Food and Drug Administration, National Institutes of Health and The National Science Foundation. Many critics indicate this should be a private industry responsibility. I hope we can in time reach an understanding that a publicly funded basic research program in this area should have high priority. As pointed out in the study the federal government should make a significant contribution to this basic research program.

The states view PHTME as an important public funded research area and have backed it with increases in funding over the past 10 years as indicated in the study. It's significant that local people support state appropriations in legislatures in the major food producing states. They must realize the importance of PHTME to the movement of agricultural products. Many check-off programs fund state research in the PHTME area.

The PHT area appears to have potential as an area of growth in the midwestern food producing states. Fewer people will be directly involved in food production on farms in the future but the overall agribusiness supporting system will provide more service to farmers. Also the "value added" involved in food processing translates into added jobs for an area. One example for Indiana is that over 60% of the hogs go out of the state to be slaughtered. The state is making serious moves to correct this by attracting slaughter facilities. This translates into new jobs. It also translates into the need for research information and educated food scientists. New industry seems to move to areas with good industrial environments including availability of technical support.

With energy and transportation costs on the increase we should see development of some food producing activities close to population centers. Let me use the poultry industry as an example. Indiana lost broiler and egg producing capacity to the southern states for a decade or so. We now are seeing a significant increase in broiler and especially egg production. Why ship grain to the south and consumer products back to the midwest and east? We are close to 50% of the consumers in the U.S. I feel the future looks bright for increased PHT industrial development in the midwest.

State governments, universities and the private sector need to work together to provide an environment to attract selected industrial development. "Value added" industries as food processing should be natural choices for the food producing states in the midwest. Maybe this explains the increase in PHTME funds from state government to the AES system.

In Indiana, state government, farm organizations, agribusiness and the university recently joined together to form the Indiana Institute for Ag Food and Nutrition, Inc. This is a non-profit group to support and develop agriculture and

agribusiness in the state. The several groups involved can jointly address problems. A strategic plan will likely be one of the early projects. What is needed? Where are the opportunities? What should state government do? What can or should the university do? There are opportunities which require teamwork. Food processing will be one of the areas involved in the plan since the state is serious about the "value added" opportunities. Our state and the nation should be exporting more "value added" food products rather than raw grains and other ag products.

The Purdue Board of Trustees has recently approved the formation of the Department of Food Science at Purdue University. This will increase emphasis on PHT research, teaching and extension programs. The added emphasis on PHT research, extension and student programs is the major contribution the university can make toward the environment needed to attract additional food processing -- "value added" industry to the state.

Most of my examples have illustrated a state perspective of the PHTME area. Let's turn to a more national picture of PHTME research. Federal policies in recent years have reduced emphasis in this area. I think this has been a mistake. Maybe the reason for this move has been lack of perspective on what the research needs are and who should be responsible for research needed.

Would it be logical to develop a list of priority research needs to keep the food industry from losing its competitive edge in the world market as well as providing the domestic market with a low cost safe food supply? Maybe it is time for appropriate government, university and food industry representatives to come together and put forth an overall strategic national plan of needs in PHTME research which could lead to sensible funding levels and supportive policies at both federal and state levels.

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Public funded research programs should focus on basic research needs plus training of M.S. and Ph.D. students at the universities. This research is to serve as a source of information for the private sector to use in their future development or applied research efforts. The M.S. and Ph.D. trainees will also be the future manpower for the private sector development effort.

One area which needs consideration in future planning is how nutritional and eating habits of the American consumer will effect post harvest technology. As we find more scientifically sound information on nutritional needs and effect of diet on health of consumers PHT may take on additional importance. Genetic change in plants or animals is a slow process. Food processing can be a faster way to make significant changes by the proper combination and processing of food ingredients.

There are significant opportunities for PHTME research to contribute to the overall economy in the food producing states. The federal government should increase its support of this area of research. In order for this to happen we may need a strategic overall plan with input from government, industry, universities and consumers.

Thank you for this opportunity.

Mr. DURBIN. Thank you, Dr. Liska.

I'd like to announce here that Mr. Skeen is going to have to leave a little early. I think he's trying to develop that Indiana market for the lamb. I hope you can stay with us as long as you can, Joe, but don't miss your plane.

At this point on the panel, I would like to introduce and welcome Dr. Kristine Coryell and Dr. Joseph Avery, from Richland Community College. I understand that you're going to give us a team effort on this, and I welcome your testimony.

Dr. CORYELL. My remarks have a distinctly local focus but I think they also do represent the over 1,200 community colleges that are located throughout the United States and, certainly, in all of your districts.

Richland Community College has completed its 11th year of operation. Since 1972, the college has grown, matured, and established itself as a vital part of the district it serves. Richland is now recognized as a key resource and major asset by the people throughout the district.

It is apparent that the college is succeeding in its mission of offering quality educational opportunities, designed specifically to meet the needs of its district residents at the lowest possible cost to students.

There are substantial enrollments in all three primary areas of educational offerings: Occupational and career programs, transfer or baccalaureate programs and the continuing education or noncredit offerings. The college has a faculty and staff who are experienced, skilled, and dedicated to excellence in teaching, counseling, and the full range of services offered to its students.

The development of Richland and the progress that has been achieved during its 11 year history, as well as some of the current characteristics of the college, are indicated by the following sample of statistics, and I do want to say again, because of where each of you are from, this would be somewhat representative of many of the community colleges throughout the country:

Richland serves all of Macon County and parts of seven other counties, a total of about 900 square miles, a total population of approximately 155,000.

Current enrollment is approximately 4,000 credit and 1,500 noncredit students each semester. This is more than three times the enrollment of 11 years ago, and represents a greater than 50-percent increase in only the last 3 years. This increase in enrollment, by the way, again is a typical pattern throughout the United States.

More than 33,000 credit students and approximately 12,000 noncredit students have been served in the past 11 years.

Approximately one half of our students are in occupational or vocational programs.

Approximately 85 percent of our students work either full time or part time. The average age of students is 28 and enrolled students have ranged in age from 16 to 84 years of age. So we serve a very wide age range and diverse background of students.

Richland, again, like other community colleges, is geared to focus on the specific educational and employment-related needs of its dis-

trict residents, including training of workers for local industries involved in today's hearing, that and the postharvest economy.

With the very nature of the national and local economies going through a transition and technological advances coming at a rapid rate, the availability of intense, up-to-date, high-quality training and retraining is essential. Richland will continue to work closely with local business firms, with labor organizations, with the agricultural community, government agencies and other educational institutions to assure that the job training needs in the Decatur area are met.

As an example, the dislocated worker center, which Congressman Durbin has worked directly with and his staff has been very helpful on this, began June 1, 1983, and is designed to help those laid off and terminated due to technological advancement and changing economic conditions.

It's estimated, by the way, that approximately—over 3,000 people just in the Decatur, Ill. area, fit that category. We're supposed to serve approximately 200 people so in terms of the amount that we can serve, based upon the funding, there is a very dramatic difference.

The dislocated worker center is to provide a comprehensive training and employment program with counseling, vocational assessment and job search assistance components. The training and retraining programs will be based upon local employment demands with an eye directed toward emerging growth areas. An examination of the training needs in agriculture and specifically in postharvest activities is now in progress.

One thing I do want to say, as the center's director, I can only emphasize that we are looking for as much help and information as possible in trying to identify those areas where there will be, where the training demands do exist.

This center, as well as the training programs the college will implement through the Federal Jobs Training Partnership Act, beginning in October 1983, will help prepare people to return to work or to obtain a better job.

It is vital that the economic base of the Decatur area become broadened and diversified if economic recovery and growth are to occur. It is our mission as a community college to adapt quickly to the changing educational and training needs of the community and to provide those programs and incorporate those methods and techniques which best prepare people for productive, satisfying employment.

More and more in today's world, the ability to earn will depend directly upon the ability to learn. Richland can teach people how to learn and then prepare them for employment through specific job training. This college, as do all community colleges throughout the United States, welcomes the opportunity to develop training programs and especially to respond to the needs related to the postharvest economy.

Thank you.

[The prepared statement of Dr. Coryell follows:]

Richland Community College

Dislocated Worker Center

Richland Community College has completed its 11th year of operation. Since 1972, the College has grown, matured and established itself as a vital part of the District it serves. Richland is now recognized as a key resource and major asset by people throughout the District.

It is apparent that the College is succeeding in its mission of offering quality educational opportunities, designed specifically to meet the needs of its District residents, at the lowest possible cost to students.

There are substantial enrollments in all three primary areas of educational offerings--occupational or career programs, transfer or baccalaureate programs and the continuing education or noncredit offerings. The College has a faculty and staff who are experienced, skilled and dedicated to excellence in teaching, counseling and the full range of services offered to students.

The development of Richland and the progress that has been achieved during its 11-year history, as well as some of the current characteristics of the College, are indicated by the following sample of statistical and general information:

-- Richland serves all of Macon County and parts of seven other counties, a total area of about 900 square miles, a total population of approximately 155,000.

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Richland Community College
Dislocated Worker Center

-- Current enrollment is approximately 4,000 credit and 1,500 noncredit students each semester. This is more than three times the enrollment of 11 years ago and represents a greater than 50 per cent increase in only the last three years.
-- More than 33,000 credit students and approximately 12,000 noncredit students have been served in 11 years.
-- Approximately one-half of our students are in occupational programs.
-- Approximately 85 per cent of students work full-time or part-time while attending Richland.
-- One out of every five students is a full-time student enrolled for 12 or more credit hours.
-- Average student age is 28. Students enrolled have ranged in age from 16 to 84.

Richland, like other community colleges, is geared to focus on the specific educational and employment-related needs of its district residents, including training of workers for local industries involved in postharvest technology and industries.

With the very nature of the national and local economies going through a transition and technological advances coming at a rapid rate, the availability of intense, up-to-date, high-quality training and

retraining is essential. Richland will continue to work closely with local business firms, with labor organizations, the agricultural community, government agencies, and other educational institutions to assure that the job training needs in the Decatur area are met.

As an example, the Dislocated Worker Center, which began June 1, 1983, is designed to help those laid-off and terminated due to technological advancement and changing economic conditions. It provides a comprehensive training and employment program with counseling, vocational assessment, and job search assistance components. The training and retraining programs will be based upon local employment demands with an eye directed toward emerging growth areas. An examination of the training needs in agriculture and specifically in postharvest activities is now in progress.

This Center as well as the training programs the College will implement through the federal Jobs Training Partnership Act, beginning in October, 1983, will help prepare people to return to work or to obtain a better job.

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Richland Community College
Dislocated Worker Center

programs and incorporate those methods and techniques which best prepare people for productive, satisfying employment.

More and more in today's world the ability to earn will depend upon the ability to learn--Richland can teach people how to learn and then prepare them for employment through specific job training. The College welcomes the opportunity to develop training programs and respond to the needs related to the postharvest economy.

Kristine W. Coryell, Ph.D.
Director, Dislocated Worker Center
Director, Community Relations
July 21, 1983

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Mr. DURBIN. Thank you.

Dr. Avery.

Dr. AVERY. I'd like to address first the importance of international markets. Here in Illinois, we say that two of each five rows of beans will find a home in foreign markets. Approximately 13 percent of the corn will go into foreign markets.

The international market is going to grow in the postharvest economy. We need to have considerable more research funded to ascertain the types and forms of agricultural products that are acceptable to various ethnic and cultural groups. I think, as Mr. Pfieffer was emphasizing the market aspect, we look around the world and as I look at names, I'm not sure, but Mr. Liska may have a southern Europe or Greek or something like that, but indicating a name that has interest in lamb.

I think that some of these ethnic groups have various tastes. We look at the oriental tastes, we look at the Spanish-oriented tastes, Latin America, so on, I think we have to meet those various tastes and this takes some determination. It cannot just be a product that can be packaged and will meet all of them. It takes modification.

Then how can we move our product into their economy at a method that is economically advantageous to both parties. I am not sure if the shirt I'm wearing is made in the People's Republic of China from American cotton but if we do not read our labels, we often find that we are wearing a product that has gone through two or three nations and we need to understand a better way to barter or trade to ship products from one area to another.

Are we concerned that the Philippines is having a drought and not producing as much coconut oil, which competes directly with our soybean oil in certain markets? These are concerns where we can meet a wide range of human needs and, at the same time, move this high percentage of our agricultural production that has to find a home in foreign markets.

I see some apologies due Mr. Skeen's cows and sheeps. I think when we begin to overlook the very high significance of animal agriculture—approximately 80 percent of the corn will go into livestock of one sort or another, poultry, swine, to a certain degree livestock, particularly dairy cows. When we look at the digestive system, particularly of the ruminant animals, cows and sheep, that they are the fermentation lab and they have for years been taking waste products and upgrading them to a real high-efficiency food product. We need to have expenditures maintained in good ruminant and swine and poultry nutrition.

I'm going to add to that that I see, with the freshwater ponds that we have along our interstates, a potential for a fish economy, where the food process byproducts could be upgraded and fed to fish.

In the Orient, for years, they have fed the poultry and then they feed the poultry waste, including the manure, to the fish and then they harvest the fish and they come up with a high-value, low-waste system. I think other possible innovative mechanisms that would involve our universities and both our State and local governments, would be a food fair or exposition that would highlight both to our American public and international consumers, some of the dramatic changes in our food production and our food forms.

This type of an educational trade show could feature corn, soybeans, wheat, and meat products, plus the related equipment that would move these products from their raw state to the consumable form. In reading the Office of Technology Assessment report, they have determined that the United States does not have a well-articulated and clearly achievable national food and agricultural goal.

I believe that there needs to be some funds or needs to be some very intense effort to develop a policy to protect the American consumer, that would protect the agricultural production sector and protect our international consumers from the devastation of shortsighted, political actions that interfere with the orderly movement of food from the producer to the consumer.

I believe that Dr. Long and Dr. Hahn both brought out that they do invest over 20 years' time span, and they start out with an anticipation. I believe the private sector probably does a much longer term planning. Yet, in going back to the prairie farmers, as far back as January 24, 1920, I see that they are talking about lifting the grain embargo against the Soviet Union or against Russia at that time.

We have continually disrupted well-developed market channels and I believe that it is this lack of a long-range policy which impacts so severely both on employment, on our educational systems and so on.

Americans' eating practices are dynamic. We can look at our fast-food source and we can have Italians, Mexicans, Americans, and European flavors. Agriculture and government must be sensitive to this shift in consumer preference.

Regulations that favor one food or form over another must be avoided if health and safety are not a significant factor.

One of the problems with the dairy industry is that the dairy industry for years asked for regulations to protect a form. Butter had to have certain characteristics, ice cream, and so what happened, the soybean industry came out with some substitute vegetable oils that made excellent substitutes and we had frozen desserts and the American dairy industry, because of a highly regulated form, lost markets and we built up tremendous surpluses of dairy products. We also have tremendous surpluses of corn and beans and wheat but these are things that are potential resources to be used in this total world economy.

In looking at the risk of developing a product—I am not a food scientist, I enjoy food—but I understand that the greatest breakthrough last year in a new food form was the Jell-O Pudding Pop. I am not sure if there is any soy or corn product in them but I suspect there are. But there were a thousand products that came to market that never succeeded and will never get shelf space. There is still a great opportunity for individuals and small businesses to develop and market new forms and flavors of food that will satisfy local or regional tastes. These may be small businesses with a few people. We have a small slaughter operation out west of town. There are some small regional processing plants that will flavor a meat product to meet a local market.

I think that we could look at—Tombstone Pizza comes to mind as something that started out in a tavern in Wisconsin and is now

marketed throughout the central region of the United States. They have a small pizza operation and I am not sure how wide their market is but there are potential for all types of food specialties that will meet a small, local market, providing work, jobs, careers for people in the food-related sector.

Years ago, there used to be a process of giving awards for certain achievements. Some of the early breakthroughs in farm machinery was because of philanthropists or awards being put out by media of the day, mostly newspapers in that time, and if a breakthrough could be achieved, there would be an award of $1,000, or more.

Possibly an incentive would be to give awards after the fact to encourage people to use research and develop new products, new forms, that would increase the market.

Richland Community College's major role is a teaching rather than a research institution. I am currently doing some research at the University of Illinois in career development of community college and university students in agriculture.

I believe that there is a great future in agriculture employment and I am doing what I can to encourage young people to advance themselves in this very vital field. But we, as an institution, at Richland will continue to be a source of information, possibly at times a source of inspiration to those developing new ideas and, I trust, a catalyst in the process of creativity for our district in the State of Illinois.

[Response to questions 3 through 6 asked of Dr. Avery follows:]

Richland Community College Foundation

July 25, 1983

Honorable Members of Congress and Fellow Citizens:

Our response will be to questions three through six.

Question 3 - What would be the principle influences and catalysts for growth in this sector of our agricultural economy:

International markets will be the principle influences for growth in the post harvest agricultural economy. Research is needed to ascertain the types and forms of agricultural products that are acceptable to various ethnic and cultural groups. A companion concern is barter or trade items that may be shifted to another consumer.

Question 4 - What innovative mechanisms would you suggest that could increase the role of the university in increasing innovation, and hence economic productivity? What role do you see for the State Government?

(1) Possible innovative mechanisms that would involve the universities, state, and local governments would be a harvest-time food fair or exposition that was regional in scope. This educational and trade show could feature corn, soybean, wheat, and meat products, plus the related equipment to move the raw farm products to consumable forms.

(2) Research in a freshwater fish economy could be productive. There are numerous borrow ponds that could be utilized along with by-product feeds which currently may be of lower value and could be fed to fish.

A small-business-focused effort could stimulate, develop, and promote concepts that would improve food, processes, or other utility. Related to this would be patent information, regulatory concerns, record, and financial data to comply with various agencies involved when bringing a new product or service to the market.

Question 5 - What is your assessment of current federal policies and investment with respect to post harvest research?

The Office of Technology Assessment has determined that the United States does not have well-articulated and clearly achievable national food and agricultural goals. One of the best outcomes of research would be a long-term food and agricultural policy that would protect the american consumer, the agricultural sector, and our international customers from the devastation of short-sighted actions which interfere with orderly movement of food from producers to the consumers.

While government policies have restricted markets, the funds invested in research have not been adequate to address solutions to burdensome surpluses.

2425 Federal Drive · Decatur, Illinois 62526 · 217/ 875-7200

Question 6 - How will the nutritional and eating habits of the American public likely affect trends in post harvest economies?

American eating practices are dynamic. Agriculture and government must be sensitive to shifts in consumer preference. Regulations that favor one food or form over another must be avoided if health and safety are not a factor.

Individuals and businesses should be encouraged to develop new forms and flavors of foods to satisfy local or regional tastes. This could be achieved through awards after the fact or through access to research facilities on a short-term basis.

Richland's major role is teaching rather than research. We, as an institution, will continue to be a source of information, possibly a source of inspiration to those developing new concepts, and a catalyst in the process of creativity for our district and the state of Illinois.

John H. Avery
Associate Professor, Agriculture
Richland Community College

Mr. DURBIN. Thank you, Dr. Avery.

I'd like to turn to my colleague, Paul Simon, to open up the questions.

Mr. SIMON. Just a couple comments and one question:

First, Dean Campbell, we see your predecessor on the Washington scene and he seems to be enjoying himself.

Dr. Coryell and Dr. Avery, I am pleased to see a community college represented. I think the community colleges contribute immensely and I had a little bit to do with starting the community college system in the State of Illinois.

On the international markets that you started your comments on, Dr. Avery, let me just mention that in addition to the embargoes being not in our interest, we now have fiscal and monetary policy in conflict. The result is interest rates are up, the dollar is up and we are not exporting as we should and could, and I don't think that's going to change until we get our fiscal house in order.

If I can lobby all four of you, one of the reasons we don't sell abroad, also, is that we are the only Nation on the face of the Earth where you can go through grade school, high school, college, get a Ph. D., and not have a year of a foreign language. You can buy in any language, you can't sell in any language. We have learned that lesson.

We also have to pay more attention, as you pointed out, Dr. Avery, to the cultural realities of other countries. Even in packaging foods, we sometimes don't package in the kinds of convenient ways that fit the culture of another country.

My one question is to you, Dean Liska: You say maybe it is time for appropriate Government, university, and food industry representatives to come together and put forth an overall strategic national plan of needs in this area.

Is anything like this happening at all?

Dr. LISKA. Well, what I am really talking about is—let me draw examples from a couple of other areas—one is in the plant science area that prior to setting up the competitive grant program in USDA, which I'm sure you're familiar with, it's part of the research that's available to land grants and other universities, really,

the experts in the area came together and sat down and said, "These are the key things that we need to do," and everybody got behind them and supported them.

Then something happened. That's not happened, as far as I can tell, in the food area. We heard some ideas coming from industry. You know, they will keep the university people honest about what really is needed, along with what the university people see as important and what the industry sees as important. I think this is going on in other countries. The Japanese, I am convinced, sit down and decide in an area, what is it they are going to spend their dollars for and train their people for? They do this all the time. We are not doing this. I don't see why the industry, the universities, and the governments involved cannot sit around the table and decide what is important in an area to really then say, "OK, we will all support this and get the dollars and these are the important things." And meet periodically and as needs change, change them.

I think we're all talking about the same piece of paper. That's, I guess, what I'm saying, and I think it's time that this happened in this area.

Mr. SIMON. I couldn't agree more and I think that may be the most—and I don't mean any disrespect to all the other testimony here—I think that may be the most important thing that's been said here today. I just think it's absolutely essential that——

Dr. LISKA. Let me make one more comment: I can't commit an organization but I have a feeling the Institute of Food Technologists, which has representatives from all of these sectors, might be interested in being involved in taking the lead in doing something like this if this were really a request.

Mr. SIMON. Well, I think somehow we ought to be working and we'll get your predecessor involved in this, Dean Campbell, and I think somehow, between Congress and the administration and the universities and the private sector, we clearly ought to be moving in this direction. In some way, I am going to be following through with you and I'm going to check with Dick Durbin and others on the subcommittee so I don't step into territory that I shouldn't be stepping into, but I think that is just absolutely essential.

Dr. LISKA. Each of the groups I mentioned will have some bias and some private ground to protect.

Mr. SIMON. Even Members of Congress have biases; yes.

Mr. DURBIN. That's hard to believe.

Dr. LISKA. If you can get a group of the really knowledgeable people from industry, Government, universities, and get them isolated somewhere for a short period of time and let them hammer these ideas out and come out of there with an overall statement that would represent the most important things as all the different groups see them and how you synthesize this out, this has worked in a couple of others. The plant area, the animal people have done it, we have not done it in this area and I'd say it's time.

Mr. SIMON. I think what you're saying fits into Dean Campbell's suggestion for more money for basic research. I think we can get the additional money. When we're spending $21 billion on an agricultural program, in fact, if we put the right money into research in this area, we're not only going to help the balance of trade, we

are going to save dollars on loan programs, target price programs, and other things.

Thank you.

Mr. DURBIN. Thank you.

Lane Evans.

Mr. EVANS. I want to pick up on a question Paul Simon might have asked if we had given him a little bit more time: I know, Dr. Campbell, that you'd like to see more money for basic research but what about the student aid cutbacks? Have they affected the numbers of students coming into the college of agriculture? And what do you see if these continued proposed cutbacks in scholarship money occur, how would that affect our numbers of people under your program?

Dr. CAMPBELL. I don't believe they have adversely affected our enrollment. I think what they have done is create a little bit of shift so that the community colleges now are picking up an additional load. It's a little more economically possible for a student to go to a community college so our transfer numbers from the community college systems to the 4-year programs at the university, that number is up. The freshman number is down slightly in our area. I anticipate that this may well be a trend that's going to be continued, with current costs.

I don't think that the reduction in financial aid has affected us very much.

Mr. DURBIN. I would just add that one of the points that Paul Simon made earlier was raised in some of our earlier hearings. That is, how to bring together public and private sector and to set some goals when you realize we do have limited resources and goals we all share, particularly in this area, and I think this fits into what Richland's role is here: We are acutely aware of the high unemployment facing us in the Midwest. As we started this hearing today, one of the suggestions was to focus in on those areas that had the most potential for employment for us, using our basic local resources. Let us not try to dream up something brand new, calling for something we don't own or have any experience in dealing with.

I'm wondering, perhaps, Dr. Campbell and Dr. Liska, you've seen experiences with other university communities where a university has been a magnet to bring together a corridor of research and even Joe Skeen's State, New Mexico, when I visited, they are in the process of trying to develop a statewide effort to coordinate a corridor of research.

Do you see the potential in this area when we're talking about postharvest technology? I have a bias, of course, representing Decatur and realizing the strength that we have here, but is there a potential for a centralization of some of this effort that might create the spinoff companies, the Global Foods, can it be done, can you see it on the horizon?

Dr. Campbell.

Dr. CAMPBELL. Well, first of all, let me say that the University of Illinois has joined with the State of Illinois in developing some areas of research that they want to expand, particularly in a high-tech area. The high-tech area is far more than genetic engineering that we hear so much about. It includes much of the same kinds of

things that we're talking about here, in terms of the postharvest utilizations, new processes, new utilization, new products, I think would be a spinoff of this. So we're committed to that effort, both in agriculture and also engineering.

I mentioned our food for century III program, which is a State-sponsored program. The State of Illinois has already invested over $40 million into an expanded physical plant at the University of Illinois, and we're hopeful that will be continued because the long-range plan is to make that about $115 million, or $120 million package, so we're hoping it will be completed.

There is another area I'd like to open up, since Paul Simon talked about where we're headed in terms of planning, and I think this is a very critical one, and that is that I see high-tech, in this case genetic engineering in particular, as being a very, very important part of what's going to happen in the production side of agriculture.

Now if, through genetic engineering, we can revamp the plant so that we get substantial more production—I know that production is, in many people's thought, a bad word, but it could be a good one—if we can double, let's say, corn production and soybean production and get unit costs down, then we get into the world market, you see, because our unit cost is down. The farmer can still generate the dollars because they are going to have tremendously increased yields. Then we have the opportunity for new products to come into play.

We're doing research now into ethanol production. The problem is that ethanol is not very competitive right now. We're doing research in our college on the use of soybean oil as a possible fuel for diesel tractors. But the problem is soybean oil is too high priced. But if you can process it and all of a sudden it becomes competitive, then we can tell those oil shieks where to take their oil, you see, and I think we're going to see a tremendous breakthrough but now is the time when we need to be doing the postharvest utilization side and I think it's a crime to be phasing down our regional utilization centers like we have at Peoria. I think it's terrible to be phasing those down because this is the time we should be increasing, getting ready for what I see as a very major production expansion. And so we can have new products, new utilizations, new exports, and be particularly competitive in the world market.

But now, as you pointed out, we're not so competitive in the world market. So I think this is an area that calls for very heavy thought. We're not asking for a lot of money. As you pointed out, in terms of the totals of the program, all that's going in is what is really a temporary thing to try help solve some of the stresses on our economy now. But we need to be looking at the longer pull and investing in research that will provide new products, new utilizations, new exports.

Mr. SIMON. I agree.

Mr. DURBIN. Dr. Liska.

Dr. LISKA. Well, I sometimes think that the word "high-tech" has captured people's attention to the point that to them it means really bringing a whole new kind of activity. Really, the other side of that is that here we have, in States like Illinois and Indiana, a major agricultural industry that we're not going to lose to New

Mexico or the Southeast because of the land and water, and so on, resource we have here. What can we do to apply modern technology to make that more competitive through this country and the world?

I think that's what we need to get the people focused on, to some degree, and not just looking at the electronics and other things we're trying to steal from somebody else. We have a base here that nobody else can do in this country, because of the natural resources, and I think it's something we need to focus on more than we have. And that's from the basic, fundamental research related to production all the way through the final use of those products, in what form their are in, as human or other. I think that is something we need to refocus on. It's always easier to look somewhere else.

Mr. DURBIN. I think as we refocus on it, and if things do work out on the positive side, the role of Richland Community College, Millikin University, and others, provide the kind of basic training for the people to be involved in and I think it's coming through loud and clear.

Thank you very much.

Our final panel I would like to call up at this time is the role of the Federal Government, Dr. William E. Riddle from Battelle Memorial Institute, Columbus, Ohio; and Dr. Robert Rhodes, Director, Agriculture Research Service Laboratory in Peoria, Ill.

STATEMENTS OF DR. WILLIAM E. RIDDLE, BATTELLE MEMORIAL INSTITUTE, COLUMBUS, OHIO; AND DR. ROBERT RHODES, DIRECTOR, AGRICULTURE RESEARCH SERVICE LABORATORY, PEORIA, ILL.

Dr. RIDDLE. I'd like to take a few moments just to highlight a few points from that testimony in case other people have not had time to read it.

The Battelle Memorial Institute, Columbus Division, is pleased to be represented here and contribute to the overall factfinding activities of this subcommittee.

As many of you are aware, Battelle recently completed a research program for the Production Credit Associations of the United States. The research program was entitled "The Future of United States Agriculture: 1983 to 2000."

The results of that research program were condensed into a book entitled "Agriculture 2000: A Look at the Future." I don't want to push the book, but in case any of you have not seen this, this is what it looks like.

In that program, Battelle examined impacts of technology on agriculture, with particular emphasis on the farm production segment. That study has invoked much discussion, regarding the changes U.S. agriculture will undergo during the next two decades.

We have only begun to tap the opportunities that exist for increasing efficiency, production, output, and income. If we are to realize the full potentials of increased efficiencies, production, output, and income, it will be necessary to increase the economic and technological efficiencies of processing and distribution systems.

Today we are addressing postharvest technology and marketing economics. It has been cited on numerous occasions that approximately 70 percent of the costs of feeding U.S. citizens are encompassed in the costs that occur after the production of the crops or livestock. It has been correctly pointed out that nearly two-thirds of the Federal and State research and development activities in agriculture have been directed toward increasing the efficiency of agricultural production—the 30 percent of the cost element of feeding U.S. citizens.

Today I will briefly address some of the future technological changes that we expect to influence the post—harvest sector of the agricultural economy over the next two to three decades. I will address some questions on the adequacy of research funding and ways to stimulate development of these technologies.

Sophisticated greenhouses are now categorized under the term "controlled environment agriculture." In these facilities, plants are grown in an atmosphere of regulated light, temperature, carbon dioxide, and relative humidity. These new greenhouses can be built near electric power generating facilities and use the waste heat from the power generation to grow crops year around, or they can be used in conjunction with the production of livestock. For example, a new generation greenhouse could be connected to a swine production facility so that the oxygen given off by the plants could be exchanged with the carbon dioxide heat generated by the animals.

If we consider some of the marketing changes, substantial impacts will be occurring in the marketing and processing of livestock.

For example, beef consumption on a per capita basis, peaked in the early 1970's. In fact, per capita beef consumption probably will be surpassed by the pork and poultry consumption before 2000. The competition between pork and poultry consumption has had dramatic impacts on the economies of beef production and distribution.

Americans are demanding less fat in their diets. In response, production and processing of lean beef will increase to the 21st century. Marketing of boxed beef, beef that has been processed into primal and subprimal cuts, will become the norm, rather than shipping whole beef carcasses because of reduced labor and handling costs, decreased transportation costs, and reduced energy usage.

The beef industry will be using electrical stimulation and hot processing of beef carcasses to provide tender beef. There will be more restructured meat products, frozen beef, health and diet beef, and beef snack foods marketed to consumers. These processed beef products will provide opportunities for greater domestic marketing, market penetration, as well as increased export opportunities for U.S. agricultural processors.

In the future, farmers may perform more processing of crops in the field in conjunction with crop harvesting. Forages are now chopped in the field before being put into silos and alfalfa can be cubed in the field to produce a high-density package of hay.

By 2000, farmers may be harvesting soybeans, for example, with a machine that extracts the oil from the seed and stores the re-

maining seed cake. Farmers will have two high-value commodities to sell, increasing total crop income potential.

Another possibility for increased processing of crops is the extraction of protein or other useful products from crops, now traditionally used for human consumption, such as protein extraction from alfalfa leaves. However, the real breakthrough for in-field processing may come in the area of high value fruits and vegetables.

For example, tomatoes are 95 percent water. A tomato is a highly processed vegetable. The food processor that develops a machine that will harvest and perform the first phase of tomato processing in the field will have a decided economic advantage over other tomato processors conventional food processing technologies.

Economies will occur in transportation, processing, and capital investment. Preliminary calculations indicate that if the breakthroughs in food technology can occur, an in-field processor could pay back the research and development and engineering costs in less than 1 year.

It has been accurately pointed out in the OTA report on postharvest technology and market economics that public funding of postharvest research relative to production research has been declining in real terms since 1978.

Much of the research has been funded by State appropriations. Presently State appropriations for postharvest research account for more than 50 percent of all public expenditures for postharvest research. Based on the technological developments that Battelle has forecast in "Agriculture 2000," we anticipate a greater need for research and development investments that can be made by both the private and public sectors of our economy.

The USDA has defended postharvest marketing research, expenditure reductions, as being appropriate since the research void would be filled by private industry. Private industry—the food industry, that is—traditionally tends to invest in research and development projects that directly benefit and support future plans that have a relatively short payoff period.

It is not readily apparent that USDA's hypothesis is supported by food industry action. Long-term research, such as the integration of satellite weather forecasting with harvesting and marketing conditions, needs to be funded by the public sector. Research with a long-term payoff not only has a higher risk associated with expenditures but also typically involves larger dollar outlays.

Research conducted by Federal and State agencies is available to both large and small firms. The benefits to society accrue beyond the private corporation funding of such work.

One of the primary catalysts for developing technology is a quantum jump in economic efficiencies. Many techhologies are developed to improve economic competitiveness of one organization over another in an industry. For example, if that in-field processor for tomatoes is developed by a major tomato processor, that tomato processor would incur reduced transportation, labor, and capital costs, and lower total investments, as compared to the traditional tomato processor.

The increased economic efficiencies would enable the innovative processor to quickly repay the substantial capital investments

needed to develop the technology and the investments in new plant and equipment.

The administrative changes directed toward consolidating agricultural research along functional activities have contributed toward a fragmentation of postharvest technology in marketing economics research throughout the Federal agencies and State agriculture experiment station system.

Executive actions indicate the potential exists for inadequate development of postharvest technologies and a high probability that we will be unable to reach the marketing and distribution potential of our agricultural system.

How can we prevent such events from occurring? We need to first develop a cohesive plan to both coordinate and integrate the postharvest research that's being conducted by State experiment stations with various Federal agencies within the USDA. Too often, postharvest research is conducted on very narrow topics and it's directed toward a small number of potential users.

Using the educational and research resources at land-grant institutions on broader topics would benefit a larger segment of society and would be more efficient use of research expenditures.

In summary, our land grant institutions have done an excellent and credible job in conducting agricultural production and distribution research. Moneys through the Hatch Act have enabled the United States to build an agricultural production and distribution system that is second to none.

Federal and State research should be conducted on problems with longer term implications. It is in this area that we need solutions. The investments needed exceed the resources of the private sector.

As we foresee the evolution of technology projected in "Agriculture 2000," we need solutions to long-term problems. If programs and activities are coordinated and directed toward the needs, then in the coming decades, our agricultural economy will develop to its potential maximum, to the benefit of the United States and the world.

Thank you. I will be more than happy to answer any questions.

[The prepared statement of Dr. Riddle follows:]

FOCUSING POSTHARVEST RESEARCH, TECHNOLOGY AND ECONOMICS

Testimony Presented Before
The Subcommittee on Investigation and Oversight
Committee on Science and Technology

United States House of Representatives
Decatur, Illinois

July 25, 1983

by

William E. Riddle, Ph.D.
Battelle-Columbus Division

The Columbus Division of Battelle Memorial Institute, Columbus, Ohio, is pleased to be represented and contribute to the overall fact finding activities of this Subcommittee. As many here are aware, Battelle recently completed a research program for the Production Credit Associations--The Future of United States Agriculture: 1983 to 2000. The results of that research program were condensed in a book entitled Agricultural 2000 - A Look at the Future. In that program Battelle examined the impacts of technology on agriculture with particular emphasis on the farm production segment. That study has invoked much discussion regarding the changes United States agriculture will undergo during the next two decades. Since the "Golden Years" of agriculture, between 1910 and 1914, the United States agricultural production system has undergone much change. Just as the farmer at the turn of the century would not recognize today's agriculture, so the farmers in the Twenty First Century will look upon the present technology for producing crops and livestock as being primative and inefficient. Yet United States agriculture has, and continues to be, one of the most productive sectors of the United States economy.

*Dr. William E. Riddle is Research Leader and Manager of Food and Agricultural Industries research activities at Battelle-Columbus Division, Columbus, Ohio.

Presently we have fewer farmers than ever before in the history of the United States. Today one farmer provides the food for more than 100 citizens; and that only accounts for about two-thirds of the agricultural production in the United States. The remaining one-third of the United States agricultural production is exported to developed and developing countries. Our agricultural base is the envy of the world. Yet, as we look to the future, we realize we have only begun to tap the opportunities for increased efficiency, production, output and income.

If we are to realize the potential increased efficiencies, production output, and income, it will be necessary to increase the economic and technological efficiencies in our processing and distribution system. Today, we are addressing postharvest technology and marketing economics. As defined, postharvest technology and marketing economics encompasses the transformations that occur to agricultural products between harvest and consumption. These techniques include functions such as storage, transportation, processing, packaging, warehousing, and distribution. It has been cited numerous times that approximately 70 percent of the costs of feeding United States citizens are encompassed in cost elements that occur after production of crops or livestock. It has been correctly pointed out that nearly two-thirds of the federal and state research and development activities in agriculture have been directed toward increasing the efficiency of agricultural production -- the 30 percent of the cost elements of feeding United States citizens.*

Today, I will briefly address some of the future technologies that will be influencing the post harvest sector of the agricultural economy during the next two or three decades. I then will address the questions of the adequacy of research funding and ways to stimulate the development of these technologies.

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*"Agricultural Post Harvest Technology and Marketing Economics -- A Technical Memorandum, Office of Technology Assessment, Washington, D. C., April 1983, p 3.

FUTURE TECHNOLOGIES INFLUENCING THE MARKETING OF AGRICULTURAL PRODUCTS

The comments made in this section of Battelle's presentation evolve from the recently completed research program conducted for the Production Credit Associations. Some of the developments and trends are just beginning to emerge as workable activities. Others are still in the latter stages of development and appear to have a high probability of becoming workable solutions during the next two decades. For a more complete description of these technologies or market innovations the reader is referred to the report summary - Agriculture 2000: A Look at the Future.*

Sophisticated greenhouses now are categorized under the term "Controlled Environment Agriculture". In these facilities plants are grown in an atmosphere of regulated light, temperature, carbon dioxide, and relative humidity. Controlled environment agriculture has substantial promise for increasing agricultural production in areas where productive land might be limited due to increasing population. These new greenhouses can be built near electric power generating facilities and use the waste heat from power generation to grow crops year around, or be used in conjunction with livestock production facilities. For example, a new generation greenhouse could be connected to a swine production operation so the oxygen given off by the plants could be exchanged with the carbon dioxide and heat generated by the animals.

Firms already are using controlled environment agriculture to produce high value crops such as bibb lettuce, tomatoes, and European cucumbers. In fact, one of these "new generation greenhouses" is located in Decatur, Illinois. The facility is adjacent to an alcohol production facility. The carbon dioxide from the alcohol fermentation is passed to the greenhouse where it produced lush green lettuce that is marketed to major nearby metropolitan areas.

*Agriculture 2000: A Look at the Future, Battelle Press, Columbus, Ohio, 1983.

If we consider some of the marketing changes, substantial impacts will be occurring with the marketing and processing of livestock products. For example, beef consumption, on a per capita basis, peaked in the early 1970's. In fact, per capita beef consumption probably will be surpassed by both pork and poultry consumption before 2000. The competition between pork and poultry consumption has had dramatic impacts on the economies of beef production and distribution. American consumers are demanding less fat in their diets. In response, production and processing of lean beef will increase by the Twenty First Century. Marketing of boxed beef, beef that has been processed into primal and subprimal cuts, will become the norm rather than shipping whole beef carcasses because of reduced labor and handling costs, decreased transportation costs, and reduced energy usage. The beef industry will be using electrical stimulation and hot processing of beef carcasses to provide a "tender" beef. There will be more restructured meat products, frozen beef, health and diet beef products and beef snack foods marketed to consumers. These processed beef products will provide opportunities for greater domestic market penetration as well as increased export opportunities for agricultural processors.

The agricultural production segment will be placing increasing emphasis upon the way agricultural products are marketed. Traditionally, high rates of production have been detrimental to farm prices and disastrous to farm incomes. Presently farmers marketing commodities such as milk, fresh produce, fruits, and beef find these products often are changed to branded products bringing substantial markups and profits to the agricultural marketer. By 2000 farmers should have the ability to differentiate products, control supplies, and improve profits. How will this be accomplished? One way could be joint ventures with marketing cooperatives and private food processing companies. These joint ventures combine the attributes of an efficient production unit controlled in the marketing channel by professional marketers that have created a demand for specialized agricultural products. The marketers have tailored products to consumer tastes and have "packaged" the products in highly desirable forms, resulting

in increased profits throughout the production and distribution channels. Firms marketing undifferentiated commodities will continue to be price takers. Firms operating as price takers will have low profits; while firms differentiating their products in the marketplace will be "price makers" and share in increased incomes.

International marketing and exports of agricultural products will be a cornerstone for continued success in United States agriculture. Recent studies estimate that the billion dollars of agricultural exports creates nearly 31,000 jobs in the United States. Successful agricultural marketers in the future will be those firms that can export products, particularly value added products. Again, as in the marketing example, firms exporting value added products will achieve added profits over those firms marketing agricultural commodities. In addition, marketing and merchandising services will need to be offered as part of a "package" in order to be highly successful in export marketing.

For the most part, agricultural cooperatives have not been leaders in commodity exporting, but now some cooperatives are becoming more active in exporting agricultural commodities. For example, through the Cooperative League of the U.S.A., the Agricultural Cooperative Development International, and Volunteer Development Corporation, cooperatives have been exporting production knowledge and technical information to developing countries. By 2000, these organizations should be showing farmers in developing nations how to produce low-cost feeds, milk, and eggs while we market higher value products to the same countries. Changing political climates, protectionism, credit needs, the high value of the United States dollar are but a few of the factors that make exporting a high risk area. However, if United States agriculture is to excel in the Twenty First Century these risks need to be taken. To develop a strong export activity will require the combined cooperative effort of both industry and government.

In the future, farmers may perform more processing of crops in the field in conjunction with crop harvesting. Forages now are chopped in

the field before being put into silos and alfafa can be "cubed" in the field to produce high density packages of hay. By 2000, farmers may harvest soybeans, for example, with a machine that extracts the oil from the seed and stores the remaining seed cake. The farmer would have two higher value commodities to sell, increasing the total crop income potential. Another possibility for in-field processing of crops is the extraction of proteins and other useful products from crops now traditionally used for human consumption, such as protein extraction from alfafa leaves.

The real breakthrough for in-field processing may come in the area of high value fruits and vegetables. For example, tomatoes are 95 percent water and tomatoes are a highly processed vegetable. The food processor that develops a machine that will harvest and perform the first phase of tomato processing in the field will have a decided economic advantage over other tomato processors using conventional food processing technologies. Economies will occur in transportation, processing, and capital investment. Preliminary calculations indicate that if the breakthroughs in food technology can occur, an in-field processor could pay back the research and development and engineering costs in less than one year.

I would be remiss if I did not discuss the impacts of the computer and electronics technology on agriculture. The influx of information and new data must be assimilated and organized so that it can be managed effectively by farmers and food industry executives for greater productivity and profits. During the past ten years computer speeds have increased more than 100 times; the density of electronic components have increased 10,000 times; the costs for computational memories have decreased more than 90 percent. Small highly sophisticated low cost computers (microcomputers) are available at prices that are declining nearly weekly. The farm computer already is in use but its future capabilities have only been barely tapped. For example, data on feed performance, fertilizer and pesticide usage, weather information, market conditions, and energy availability are but a few of the variables that might be considered by today's farmers.

The computer can broaden the farmers' field of knowledge, keep him informed of recent market developments, and aid in timely decision-making -- all in a matter of seconds.

Presently there is enough electronics technology available to accommodate the hardware needs of agriculture for the next ten years without further technological development. However, relatively few companies are developing software applicable to agriculture. Often the cost of software development by the user can be many times greater than the cost of the computer. It is difficult for the average farm professional or the average agribusiness executive that is not equipped to do programming to circumvent high software costs. Conversely, the demand for agricultural oriented programs is not large enough for many commercial companies to fund the development costs. Thus, a negative influence exists. Computers are not purchased because of high software costs. Software is not developed because there is no demand created by a large computer base.

While the agricultural software market is not particularly large, firms are developing programs for farms and agribusiness to use as aids in decision-making. Simulation models, sensitivity analysis, market forecasts are but a few of the applications that are presently being developed.

Our sophisticated electronics technology will not wait for agriculture to catch up. New developments, such as fiber optics, will replace wires in a number of applications. Fiber optics are immune to noise and are highly resistant to failure. Communications among people in several farm buildings or in remote locations will be simplified, and control of remote equipment for monitoring environmental conditions will become a reality. Individual animals will be recognized remotely and fed individually formulated rations; weeds will be differentiated from crops permitting selective spraying; machines will be steered automatically. These developments will enable farming to become fine tuned to the environment. To use a cliché, "We will now even be able to extract the squeal from the pig".

RESEARCH FUNDING AND STIMULATION OF NEW TECHNOLOGIES

It has been accurately pointed out in the OTA report on postharvest

technologies and marketing economics that public funding of post-harvest research relative to production research has been declining in real terms since 1978. Much of the research has been funded by state appropriations and presently state appropriations for postharvest research account for more than 50 percent of all public expenditures for postharvest research. Based on the technological developments that Battelle has forecast in Agriculture 2000, we anticipate a greater need for research and development investments to be made by both the private and public sectors of our economy.

There is no question that we will have the agricultural capability to produce crops and products in substantial excess of the quantities now being produced. As those products come into the marketplace, there will be a need for strong marketing programs and product export programs. Commodities need to be exported to countries such as Japan, the U.S.S.R. and China. Value added products need to be exported to both developed and developing countries. International loans probably will be made by United States financial institutions to support the growth of agricultural exports. Loans will be made to industry to support capital investments needed to integrate sophisticated computer control of materials handling systems, process control systems, and new mechanization techniques, such as in-field processing. Greater investments will be needed to support the increased demands that will be placed upon our food physical distribution system during the coming years.

The USDA has defended past postharvest marketing research expenditure reduction as being appropriate since the research void would be filled by private industry. Private industry, the food industry, traditionally tends to invest in research and development projects that directly benefit and support future plans and have a relatively short pay-off period. It is not readily apparent that USDA's hypothesis can be supported by food industry actions. Longer term research, such as the integration of satellite weather forecasting with harvesting and marketing conditions needs to be funded by the public sector. Research with a longer

term payoff not only has higher risk associated with the expenditures, but also typically involves larger dollar outlays. Research conducted by federal and state agencies is available to both large and small firms. The benefits to society accrue beyond a private corporation funding such work.

One of the primary catalysts for development of a technology is a quantum jump in economic efficiency. Many technologies are developed to improve the economic competitiveness of one organization over another in an industry. For example, if an in-field processor for tomatoes is developed by a major tomato processor, that processor would incur reduced transportation, labor, capital costs and lower total capital investment compared to a competing tomato processor. The increased economic efficiency would enable the innovative processor to quickly repay the substantial capital investments needed to develop the technology and the investments in new plant and equipment.

Recent market research under the supervision of Cooperative State Research Services appears to be directed more toward scientific questions rather than postharvest marketing questions. For example, a Cooperative State Research Service evaluation of research conducted by state agricultural experiment stations revealed the research primarily emphasized productivity and product quality. Only in recent years has research emphasized new areas such as health and safety, energy conservation and environmental protection and loss reduction. The evaluation hypothesized that private sector financing would not be sufficiently great to meet the needs of society. Administrative changes directed toward consolidating agricultural research along functional activities has contributed toward a fragmentation of postharvest technology and marketing research throughout federal agencies and the State Agricultural Experiment Station system. These conclusions and executive actions indicate the potential exists for inadequate development of postharvest technologies and a high probability that we will be unable to reach the marketing and distribution potential of our agricultural system. How can we prevent these events from occurring?

We need to first develop a cohesive plan to both coordinate and integrate the postharvest research being conducted at state agricultural experiment stations various federal agencies and within the USDA. Too often postharvest research is conducted on very narrow topics and is directed toward a small number of potential users. Using the educational and research resources of land grant institutions on broader topics that would benefit a larger segment of society would be a more efficient use of research expenditures.

There appears to be a need for coordinating research among state agricultural stations and the USDA regional laboratories to benefit a region. The OTA report on postharvest technologies indicates the majority of the benefits of federal and state research expenditures flow to areas with high population concentrations. Stronger planning and coordination of research, and the subsequent dissemination of information to industry on a regional basis, should ensure greater relevance of research topics and greater efficiency of research expenditures. Benefits still would flow to the states with high population concentrations but the stronger planning and coordination efforts should be of greater use to the region's agricultural enterprises.

Our land grant institutions have done an excellent and credible job in conducting agricultural production and distribution research. Monies through the Hatch Act have enabled the United States to build an agriculture production and distribution system that is second to none. Federal and state research should be conducted on problems with longer term implications. It is in this area that we need solutions, and the investments needed exceed the resources of the private sector. As we foresee the evaluation of technology projected in Agriculture 2000, we need solutions to the long-term problems. If the programs and activities are coordinated and directed toward the needs, then in the coming decades our agricultural economy will develop to its maximum potential to the benefit of the United States and to the World.

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Mr. DURBIN. Thanks, Dr. Riddle.

We will hear from Dr. Rhodes.

Dr. RHODES. I won't proceed very long. I assure you of that.

I thought I might make a couple of comments, however, and the main one is that nothing I've heard here this morning disappoints me in the sense that I am convinced that what we are doing, at least at our center, pretty well matches what the needs and expectations I heard expressed by other people. We do coordinate and we have cooperative agreements. We have three or four with Illinois; we have at least one I think of with Purdue, on various subjects that I heard mentioned as important in the postharvest technology area, such as the heat-abused fats and the safety and quality of fats, work that is being done in the food science department at the University of Illinois with Dr. Perkins, in association with our lab.

So we've looked at new storage methods for grains, corn at Purdue in cooperation with them, things of that sort. We've been actively concerned for years in terms of technology transfer that I heard the gentleman from Global Foods talking about, including the help for small business as exemplified by our part of the new industry based on soybeans and based, of course, on the oriental knowledge that has been turned into a science; we had a major part, then, in bringing that science to the development of small businesses all over the United States, but it is a significant market for soybeans.

Right now the agency is looking at cuphea as a new crop, particularly for the Pacific Northwest. I heard this morning mentioned the drought in the Philippines by Dr. Avery and what that has meant is that the coconut, it's interesting, the drought in the Philippines has meant that the coconut is not doing well. It also means that the electricity, hydroelectric power used to process

coconuts has diminished and so there is a shortage of lauric acid, which is one of the components of coconut and ends up in the United States as an ingredient in cosmetics.

Cuphea, to make a long story short, is a source of lauric acid, a domestic source, a strategic material, if you put it that way.

We have been instrumental in the development of nonfood uses of starch, particularly, and these have usually been taken over, as was mentioned, by small industry. It turns out, at least my understanding of the matter is that if a new product is not sufficiently large volume, a large company doesn't want to touch it, it isn't worth their effort. And the net result is things like the superabsorbent that the center developed, have come on the market as a result of small industries. And we have technology in the works now that would continue that history of development of small industries.

Two other things I think I might mention that I see as major questions. I've heard a number of people say that we need to have a national plan or a plan of priorities and I wouldn't argue with that but I would remind the committee, if I may, the Congressmen and others, that Dr. Carter told in her testimony that ARS has a plan, both a long-range strategic plan that goes out 50 years and a shorter term plan; all of these plans are based on the identification of certain questions in the state of science in terms of the long-range plans and then the shorter range plans on immediate problems over the next few years that we see need addressing.

I would submit that this plan can and should be considered in any broader or longer scale plan that people might envision for postharvest technology.

The other thing that concerns me in that I would suggest needs attention and the GAO report addressed the matter, and that is the proper role for the three principal players in the postharvest sector: The private sector, the universities experiment stations and so on, and the Federal Government. I think if there is any long-term plan and if there are priorities established, that among those priorities ought to be clear statements, to the best that we are able to, about what our respective roles are and how they might best interact.

Thank you.

Mr. DURBIN. Thank you, Dr. Rhodes.

Do you feel that your laboratory facility in Peoria, that there has been this sort of attention to postharvest research that we've all talked about this morning, in terms of your own budget, for example, over the past several years, and in terms of professional employees, and the like?

Dr. RHODES. I am not an economist so I can't do constant dollars. But the record will show that in terms of number of employees, that the budget has had an impact and we have fewer employees than we had 10 years ago.

Mr. DURBIN. Do you see an increased need, though, in terms of what you are trying to accomplish at the laboratory, an increased need for resources and personnel?

Dr. RHODES. Well, that's like walking a child into a candy store.

Mr. DURBIN. Be restrained.

Dr. RHODES. I am a scientist by training and still I hope by spirit and so, under those conditions—under any condition, rather, there are always more questions of interest and questions that could stand research, and so forth, than we can handle or any number of people can handle.

I think in terms of return on investment in the long haul in terms of the importance of postharvest technology, that nationwide, as a country, we should be investing more, yes.

Mr. DURBIN. We don't want to be caught in the predicament we heard in earlier testimony from the gentlemen at Staley and ADM, of losing some very fundamental research to other countries and then paying for it in the future. I suppose where I am directing my inquiry is to whether or not you feel we are missing those opportunities that down the line we will come to regret as being shortsighted economy?

Dr. RHODES. Well, that's what priority setting does to you, if I may answer it that way. Since we can't do everything all the time, we as a country and an agricultural research service in our center, and every other organization always has to set priorities to handle finite resources.

In the example given, it's certainly true, that the United States has not been active in the production and use of enzymes as a processing tool. Now, why that is so probably has a lot of answers, one of which is that they didn't perceive a very large market at the time. In other words, it isn't something, perhaps a small business can do and, yet, it is too small a market for some of the major pharmaceutical companies or whomever might be producing enzymes.

On the other hand, they undoubtedly had alternate uses for their funds. We didn't work on it at the northern center. We chose instead to work on, for example, in the same era, the production of microrganisms that produce extracellular polysaccharides.

Well, the result of that is the existence of xanthan gum which is 20,000 metric tons, at least, production a year from starch or corn sugar, whatever, and appears in all the salad dressings you're likely commonly to eat.

So the choice was made, if I can put it that way in a general sense, and you came out with one thing instead of the alternative. Who is to say which is the best?

Hindsight is a very valuable thing.

Mr. DURBIN. Thank you.

Dr. Riddle, I guess one of the questions I hear, one of the fascinating aspects you've brought up anew here, is the in-field processing, that we would move more toward the local producer in terms of processing rather than centralizing into the larger plant facilities.

Do you see that on the horizon in terms of research now in equipment and machinery that would meet that need?

Dr. RIDDLE. Well, I've talked to some of the members of the traditional agricultural equipment industry and they certainly are not indicating that that's a direction that they are funding research.

There are some private companies that are looking toward solving part of that problem. Again, to get a competitive edge, and

that's why I say the high-value vegetable crops provide that incentive, so that's where you expect the dollars to go.

I see in-field processing as one of the last places where we can begin to really reach some economies of scale, so to speak, and really cut the cost of food production. Who funds it? I don't know, but it's there and the private sector will fund it if the economic advantages are there. There are some very hellish and very complex technology problems. For example, technology to crush the soybean and to extract the oil in the field doesn't exist. I'm a strong believer in technology. I've watched it solve a lot of problems. I may not have the solutions. But it will come in time.

Mr. DURBIN. Lane Evans.

Mr. EVANS. No questions.

Mr. DURBIN. Paul Simon.

Mr. SIMON. Just one brief comment: We appreciate your testimony, both of you. I think the point you make, Dr. Rhodes, ought to be underscored and that is as you proceed with some kind of plan where we coordinate the three areas, that we ought to be very specific about who has what responsibility. I think one of the great mistakes that was made in the recent report to the President on education was everyone said it was a fine report and the Federal Government says, "Yes, fine report, you do it at the State and local level." The State and local level said, "You do it at the Federal level." And a lot of wheel-spinning.

I think it is important that we coordinate, that we have not only the ARS plan but that we decide who has what responsibility, as we develop such a plan.

I thank you both for your testimony.

Thank you, Mr. Chairman.

Mr. DURBIN. Thank you very much and I'd like to say in closing the public portion of this hearing, that I think what we set out to do was bring together some of the people that are recognized around the country as having some expertise in this area of postharvest technology. We have found, not to our great surprise, that there are excellent experts from around the country and, yet, in our own backyard some of the more influential and important people in the future developments in this area are right here.

I hope that what we have accomplished this morning is to evoke some thought on the parts of the private and public sector, university community, and individual citizens right here in this hearing, to think about where we are headed and how it's going to benefit us in the long run.

In my estimation, one of the things that keeps coming through as a common thread, is the need for a cohesive plan on postharvest technology research. So we, as a nation, would make sure that those limited dollars which we have to spend on research are spent most effectively in terms of the future needs of our country and the world, in terms of putting areas like the Midwest—Illinois, Indiana, Ohio—wherever it might be, in the perspective of being leaders in the world economy in generations to come.

I thank all of you for your patience this morning. I thank the witnesses on the panel and I may be seeing more of you in just a few minutes.

Thank you.

[Whereupon, at 12:37 p.m., the subcommittee was adjourned.]

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